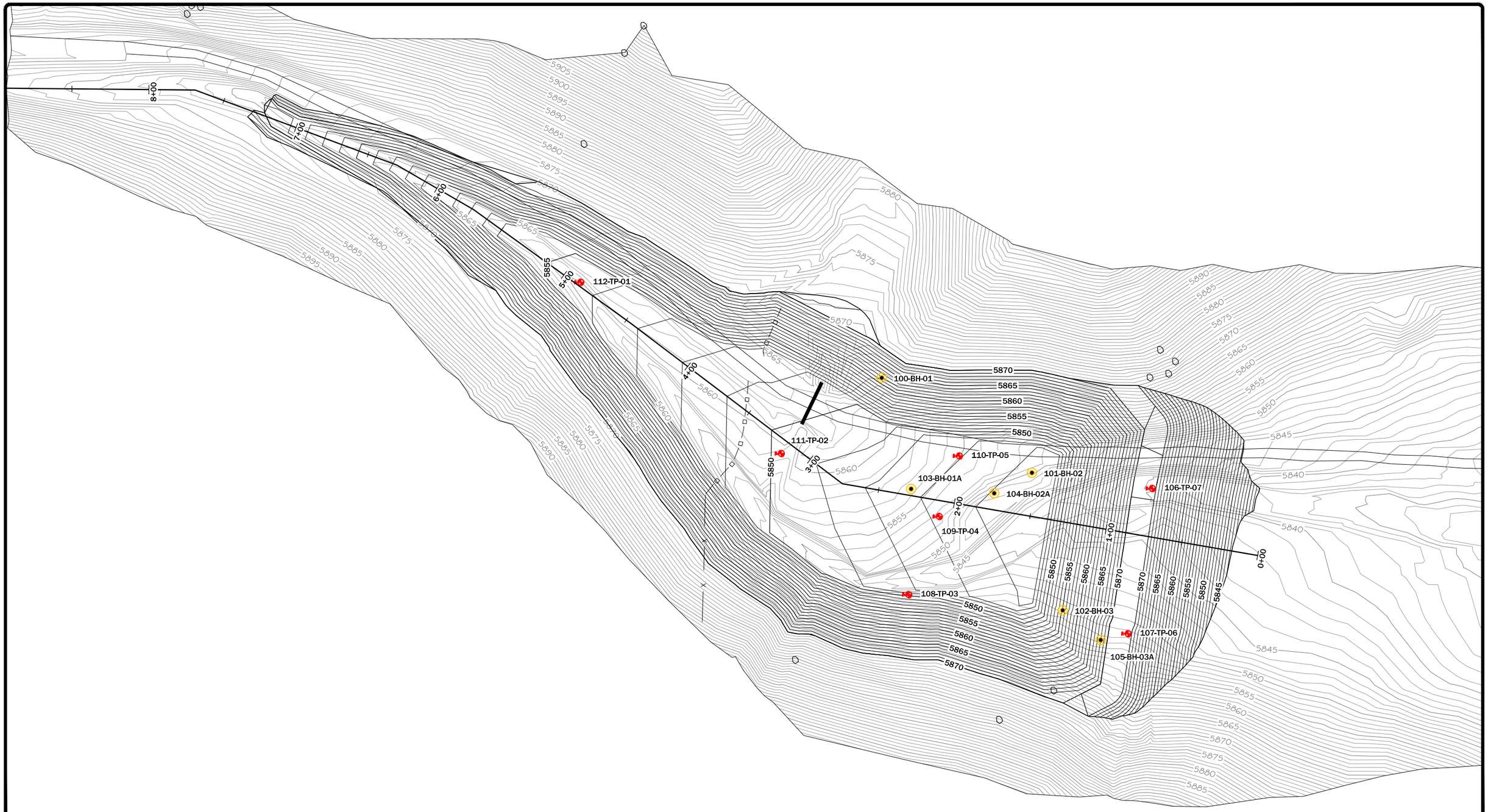
Geotechnical Field Investigation and Laboratory Data



CUT = 12,218CY
FILL = 9,837CY
NET = 2,380 CY

167

DISPLAYED AS:
COORD SYS/ZONE: MONTANA STATE PLANES
DATUM: NAD83, NAVD88
UNITS: INT. FEET
SOURCE: PIONEER/ESRI

SCALE IN FEET
0 30 60

FIGURE 1

PIONEER TECHNICAL SERVICES, INC.
106 PRONGHORN TRAIL, SUITE A
BOZEMAN, MONTANA 59718
(406) 388-8578

BANNACK STATE PARK
DETAILED DESIGN
POND DESIGN
07/27/16

DATE: 07/27/16

ATTACHMENT A – Test Pit and Borehole Logs

Drill Hole No. TP-01

PROJECT NAME: Bannack State Park	
DATE STARTED / FINISHED: 7/6/16 - 7/6/16	DRILLER: R.E. Miller
LOGGED BY: Niki Griffis	DRILL TYPE: Cat 420 E Rubber Tired Backhoe
GROUND SURFACE ELEVATION: 5849.9 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (MTSP NAD 83) N354159.3970', E1067176.9210'	HAMMER TYPE:

WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	Field SPT 'N'	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		1						Moist to wet, Brownish yellow [10YR 6/6], GRAVEL with Clay and Sand, GP-GC, low plasticity, strong reaction to HCl, Gravels becoming coarser with depth, gravels and cobbles are subrounded to subangular, random cobbles and boulders throughout profile up to 24" diameter, random large boulders to 5.0' diameter on surface nearby the test pit.						roots visible to approximately 3.0'
		2												
		3												
		4												
		5												
		6			X	G16228								
		7												
		8												
		9												
		10												
		11												Total Depth= 11.4', no free water encountered while excavating
		12												
		13												

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PIONEER TECHNICAL SERVICES, INC.

CLIENT: Montana Fish Wildlife and Parks	
ADDRESS: 1522 9th Ave. Helena, Montana 59620	
PHONE NUMBER: 406-841-4001	

DRILL HOLE LOG TEST PIT LOGS.GPJ 9/2/16

Drill Hole No. TP-02

PAGE 1 of 1

PROJECT NAME: Bannack State Park	
DATE STARTED / FINISHED: 7/6/16 - 7/6/16	DRILLER: R.E. Miller
LOGGED BY: Niki Griffis	DRILL TYPE: Cat 420 E Rubber Tired Backhoe
GROUND SURFACE ELEVATION: 5858.4 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (MTSP NAD 83) N354322.1770', E1067189.3790'	HAMMER TYPE:

WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	Field SPT 'N'	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		1						Dry to moist, Yellowish brown [10YR 5/4], SILTY GRAVEL with Sand, GM, non-plastic, strong reaction to HCl, gravels and cobbles are subround to angular, most gravels are 3" minus, with random cobbles and boulders throughout, encountered a 15" diameter boulder at approximately 8.0'.						0-2" very thin sod mat
		2												
		3												
		4												
		5												
		6												
		7												
		8												becoming more difficult to excavate at approximately 8.0'
		9			X	G16229								
		10												
		11												Total depth=11.1'
		12												
		13												

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DRILL HOLE LOG TEST PIT LOGS.GPJ 9/2/16

Drill Hole No. TP-03

PAGE 1 of 1

PROJECT NAME: Bannack State Park	
DATE STARTED / FINISHED: 7/6/16 - 7/6/16	DRILLER: R.E. Miller
LOGGED BY: Niki Griffis	DRILL TYPE: Cat 420 E Rubber Tired Backhoe
GROUND SURFACE ELEVATION: 5846.5 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (MTSP NAD 83) N354239.3520', E1067097.7410'	HAMMER TYPE:

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	Field SPT 'N'	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		0						Dry to moist, SAND with Gravel, SP, non-plastic, loose, sands are course grained, gravels are fine grained.						
		1						Moist to wet, Yellowish brown [10YR 5/6], GRAVEL with Sand, GP, non-plastic, loose, strong reaction to HCl, with boulders and cobbles, boulders to approximately 24" diameter.						
		2												
		3												
		4												Hole caving badly at 4.0'
		5				G16230								
		6				G16231		Wet, Yellowish brown [10YR 5/6], GRAVEL with Clay and Sand, GP-GC, low plasticity, strong reaction to HCl, gravels subrounded to subangular.	45	21				
		7						Moist to wet, Yellowish brown [10YR 5/6], GRAVEL with Sand, GP, non-plastic, strong reaction to HCl, with cobbles and boulders up to 24" maximum diameter.						Difficult digging at 6.0'
		8												Excavator refusal at 7.5', bedrock or large boulders encountered Total Depth=7.5' No free water encountered while excavating
		9												
		10												
		11												
		12												
		13												

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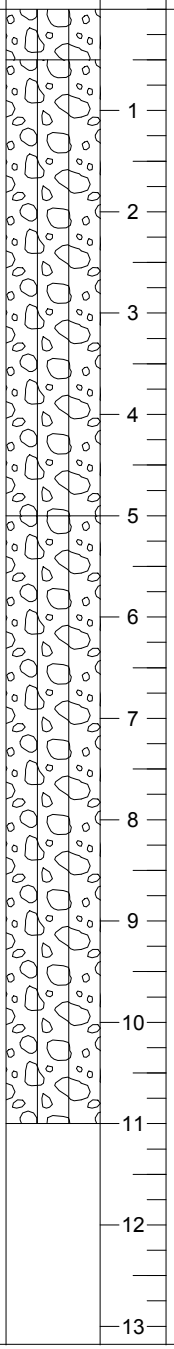
PHONE NUMBER: 406-841-4001	

DRILL HOLE LOG TEST PIT LOGS.GPJ 9/2/16

Drill Hole No. TP-04

PROJECT NAME: Bannack State Park	
DATE STARTED / FINISHED: 7/6/16 - 7/6/16	DRILLER: R.E. Miller
LOGGED BY: Niki Griffis	DRILL TYPE: Cat 420 E Rubber Tired Backhoe
GROUND SURFACE ELEVATION: 5852.6 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (MTSP NAD 83) N354219.5470', E1067148.4640'	HAMMER TYPE:



WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	Field SPT 'N'	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		0						This log is part of a report prepared by Pioneer Technical, Inc. for this project and should be read with the report. This summary applies only at the location of the boring and at the time of the drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplication of actual conditions encountered.						
								Dry to moist, SILTY GRAVEL with Sand, GM, non-plastic, gravels angular to 3" maximum diameter.						0-2" thin sod mat
		1						Dry, Brown, SILTY GRAVEL with Sand, GM, non-plastic, strong reaction to HCl, gravels angular to 3" maximum diameter, encountered subrounded 15" diameter boulder at 5.0'.						
		2												
		3												
		4												
		5						Dry, Yellowish brown [10YR 5/4], SILTY GRAVEL with Sand, GM, non-plastic, strong reaction to HCl, gravels and cobbles increasing in size to 8" maximim diameter, becoming more difficult to excavate.						
		6												
		7												
		8			X	G16232								
		9												
		10												
		11												Total Depth= 11.0', No free water encountered while excavating
		12												
		13												

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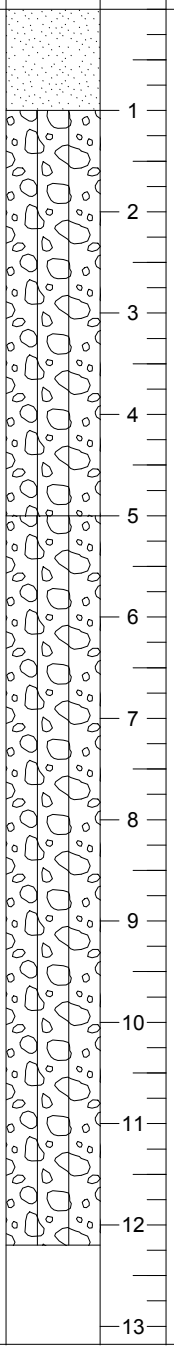
DRILL HOLE LOG TEST PIT LOGS.GPJ 9/2/16

Drill Hole No. TP-05

PAGE 1 of 1

PROJECT NAME: Bannack State Park	
DATE STARTED / FINISHED: 7/6/16 - 7/6/16	DRILLER: R.E. Miller
LOGGED BY: Niki Griffis	DRILL TYPE: Cat 420 E Rubber Tired Backhoe
GROUND SURFACE ELEVATION: 5855.1 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (MTSP NAD 83) N354206.5030', E1067187.8250'	HAMMER TYPE:



DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	REMARKS / TESTING
				G16233		Dry to moist, Dark brown [10YR 3/3], SILTY SAND with Gravel, SP, no to low plasticity, loose, gravels subangular to 1" maximum diameter, easy digging.	very thin sod mat, less than 1" thick
1						Dry, Dark yellowish brown [10YR 4/4], SILTY GRAVEL with Sand, GM, non-plastic, loose, strong reaction to HCl, most gravels are angular to 1" maximum diameter, random angular cobbles to 12" maximum diameter.	
2				G16234			
3							
4							
5						Dry, Yellowish brown [10YR 5/4], SILTY GRAVEL with Sand, GM, non-plastic, loose, strong reaction to HCl, higher gravel percentage than above, gravels angular to 3" maximum diameter, easy digging.	
6							
7							
8							
9							
10							
11				G16235			
12							Total depth=12.2' No free water encountered while excavating
13							

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LIQUID LIMIT | PLASTIC LIMIT | Field SPT 'N' | DRY DENSITY (pcf) | MOISTURE (%)

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ADDRESS: 1522 9th Ave.
Helena, Montana 59620

PHONE NUMBER: 406-841-4001

DRILL HOLE LOG TEST PIT LOGS.GPJ 9/2/16

Drill Hole No. TP-06

PROJECT NAME: Bannack State Park	
DATE STARTED / FINISHED: 7/6/16 - 7/6/16	DRILLER: R.E. Miller
LOGGED BY: Niki Griffis	DRILL TYPE: Cat 420 E Rubber Tired Backhoe
GROUND SURFACE ELEVATION: 5851.4 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (MTSP NAD 83) N354096.9400', E1067072.3590'	HAMMER TYPE:

WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	Field SPT 'N'	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		1						Dry to moist, Brown [10YR 4/3], SILTY GRAVEL with Sand, GM, non-plastic, strong reaction to HCl, becoming drier with depth, gravels have calcium carbonate coatings, most gravels 3" maximum diameter, some random cobbles to 8" maximum diameter.						
		2												
		3												
		4												
		5												
		6												
		7												
		8												
		9												
		10			X	G16236								
		11			X									Total Depth = 11.5', no free water encountered while excavating
		12												
		13												

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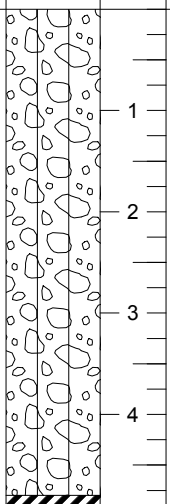
DRILL HOLE LOG TEST PIT LOGS.GPJ 9/2/16

Drill Hole No. TP-07

PAGE 1 of 1

PROJECT NAME: Bannack State Park	
DATE STARTED / FINISHED: 7/6/16 - 7/6/16	DRILLER: R.E. Miller
LOGGED BY: Niki Griffis	DRILL TYPE: Cat 420 E Rubber Tired Backhoe
GROUND SURFACE ELEVATION: 5839.8 ft	HOLE DIAMETER:
BOREHOLE LOCATION: (MTSP NAD 83) N354081.1110', E1067166.7220'	HAMMER TYPE:



DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	Field SPT 'N'	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
						This log is part of a report prepared by Pioneer Technical, Inc. for this project and should be read with the report. This summary applies only at the location of the boring and at the time of the drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplication of actual conditions encountered.						
0						Dry to moist, Dark yellowish brown [10YR 3/4], SILTY GRAVEL with Sand, GM, non-plastic, loose, strong reaction to HCl, sands coarse grained, gravels subround to subangular.						
3			X	G16238								
5			X	G16237		Moist to wet, Brown [10YR 5/3], FAT CLAY, CH, high plasticity, strong reaction to HCl, inclusions of sand and silt.	93	37			40.5	
8			X	G16239		Moist to wet, Yellowish brown [10YR 5/4], SANDY CLAY with Gravel, CL, low plasticity, strong reaction to HCl, gravels angular to subangular.						Total Depth=11.3', no free water observed while excavating No large cobbles or boulders encountered

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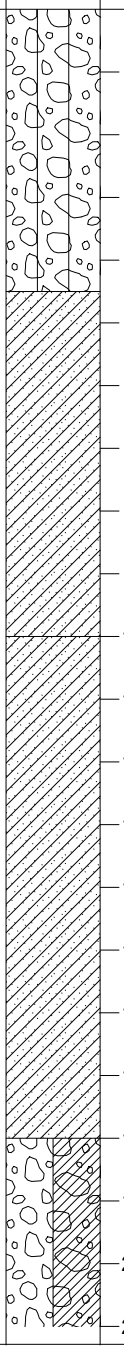
PHONE NUMBER: 406-841-4001	

DRILL HOLE LOG TEST PIT LOGS.GPJ 9/2/16

Drill Hole No. BH-01

PROJECT NAME: Bannack State Park	
DATE STARTED / FINISHED: 7/6/16 - 7/7/16	DRILLER: Axis Drilling
LOGGED BY: Jeff Riedel	DRILL TYPE: Davey-Kent
GROUND SURFACE ELEVATION: 5865.1 ft	HOLE DIAMETER: 6-inch ODEX
BOREHOLE LOCATION: (MTSP NAD 83) N354257.0190',E1067238.5830'	HAMMER TYPE: 140 lb Auto



DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	Field SPT 'N'	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
						This log is part of a report prepared by Pioneer Technical, Inc. for this project and should be read with the report. This summary applies only at the location of the boring and at the time of the drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplication of actual conditions encountered.						
1						Dry, Light brown, SILTY GRAVEL with Sand, GM, strong reaction to HCl.						Cuttings: Dry, light brown angular chips, approx. 3/8 inch diameter and sand, multi colored chips
2												
3												
4												
5						Moist, Reddish brown [5YR 5/3] Bozeman Group Silt/Claystone and Conglomerate, decomposed to residual soil, CLAYEY SAND with Gravel, SC, low to medium plasticity, strong reaction to HCl.						Top of decomposed bedrock at 4.5 feet
6				G16240	67				32		24.5	Cuttings: Moist, greenish gray, clayey sand clumps, traces of gravel chips
7				G16241								
8												
9												
10						Moist, Reddish brown [5YR 5/3] Bozeman Group Silt/Claystone and Conglomerate, decomposed to residual soil, CLAYEY SAND with Gravel, SC, low plasticity, strong reaction to HCl, traces of decomposed argillaceous sandstone, yellow green, breaks with finger pressure.						
11				G16242	78				99		2.1	
12				G16243								2-inch spoon, 50 blows/4 inches , blows uniform, gradually got stiff
13												Hard drilling
14												Cuttings: Moist, greenish gray, clayey sand clumps, with multi-colored gravel chips approx. 3/8 inch max
15												
16					0				50			2-inch spoon, 50 blows/ 3 inches
17				G16244								very dusty drill cuttings
18						Moist, Bozeman Group Conglomerate, decomposed to residual soil, GRAVEL with Clay, GP-GC, low to medium plasticity, cobbles react with HCL, field slake test shows swelling potential.						Firm, very small chips (1/4 to 1/8 inch), smooth drilling. Chips are red, black, orangish tan and gray
19												
20					80							Switch to Core HQ3
21												

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PHONE NUMBER: 406-841-4001	

DRILL HOLE LOG DRILL HOLE LOGS.GPJ 9/2/16

PROJECT NAME: Bannack State Park

Drill Hole No. BH-01

WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	Field SPT 'N'	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		22						Moist, Bozeman Group Conglomerate, decomposed to residual soil, GRAVEL with Clay, GP-GC, low to medium plasticity, cobbles react with HCL, field slake test shows swelling potential. *(Continued)*						
		23					80	Moist, Light brownish gray [2.5Y 6/2] Bozeman Group Argillaceous Sandstone, decomposed to residual soil, CLAYEY SAND, SC, low to medium plasticity, fine grained, weak, fresh.						RQD=0%
		24												
		25						Moist, Gray [2.5Y 6/1] Bozeman Group Conglomerate, decomposed to residual soil, CLAY with Gravel, CL-CH, moderate strength, gray matrix with black, gray, pink cobbles, reacts with acid.						
		26					100							RQD=0%
		27												
		28					114							Difficult drilling, driller lost water circulation Decomposed bedrock, clays are blocking off bit and no return water, too much water pressure washes out material, not enough water pressure and bit blocks off RQD=0% Total Depth =28.2 feet
		29												
		30												
		31												
		32												
		33												No Groundwater encountered while drilling
		34												
		35												
		36												
		37												
		38												
		39												
		40												
		41												
		42												
		43												
		44												

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Helena, Montana 59620

PHONE NUMBER: 406-841-4001

DRILL HOLE LOG DRILL HOLE LOGS.GPJ 9/2/16

Drill Hole No. BH-02

PROJECT NAME: Bannack State Park	
DATE STARTED / FINISHED: 7/7/16 - 7/8/16	DRILLER: Axis Drilling
LOGGED BY: Jeff Riedel	DRILL TYPE: Davey-Kent
GROUND SURFACE ELEVATION: 5849.9 ft	HOLE DIAMETER: 6-inch ODEX
BOREHOLE LOCATION: (MTSP NAD 83) N354159.3970', E1067176.9210'	HAMMER TYPE: 140 lb Auto

This log is part of a report prepared by Pioneer Technical, Inc. for this project and should be read with the report. This summary applies only at the location of the boring and at the time of the drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplication of actual conditions encountered.

DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	Field SPT 'N'	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
1–4						Dry, Light brown [7.5YR 6/4], SILTY GRAVEL with Sand, GM.						
5	X		X			Dry, Dark yellowish brown [10YR 4/4], SANDY SILT with Gravel, ML, low plasticity, strong reaction to HCl, trace of gravels on top of spoon sample.						2-inch spoon
6	X		X	G16245	39				11		7.1	
7–8			X	G16246		Dry, Yellowish brown [10YR 5/4], SILTY GRAVEL with Sand, GM, no to low plasticity, strong reaction to HCl.						Cuttings: Dry, angular to subangular 1/2 inch maximum diameter chips, very dusty
9–10			X									2-inch spoon
11	X		X	G16247	39				24		2.3	Silts collapse when water is added, possible loess
12–13			X	G16248								Cuttings: Dry, angular to subangular, gravels very dusty
14–15			X									
16	X		X	G16249	39	Dry, Brown [10YR 5/3], SILTY GRAVEL with Sand, GM, no to low plasticity, strong reaction to HCl, traces of roots in interbedded silt layers.			50		1.3	2.5 inch spoon, 50 blows/5 inches
17–18			X	G16250								Cuttings: Dry, angular, much coarser drilling, cobbles
19			X			Moist, Grayish brown [2.5Y 5/2] Bozeman Group Argillaceous Sandstone/siltstone, decomposed to residual soil, Lean Clay with Sand, CL, medium plasticity, strong reaction to HCl, field slake test shows swelling potential.						Cuttings: Change to clumps of clay with sand.
20		X	X	G16251	90							
21				G16252								

PIONEER TECHNICAL SERVICES, INC.

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PHONE NUMBER: 406-841-4001	

DRILL HOLE LOG DRILL HOLE LOGS.GPJ 9/2/16

PROJECT NAME: Bannack State Park

Drill Hole No. BH-02

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	Field SPT 'N'	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		22						Moist, Grayish brown [2.5Y 5/2] Bozeman Group Argillaceous Sandstone/siltstone, decomposed to residual soil, Lean Clay with Sand, CL, medium plasticity, strong reaction to HCl, field slake test shows swelling potential. *(Continued)*						Clayey sand cuttings becoming more rocky at 22.5 feet, little to no clay clumps
		23				G16252		Moist, Gray [N5] Bozeman Group Argillaceous Sandstone/siltstone and conglomerate, decomposed to residual soil, CLAYEY SAND with Gravel, SC, strong reaction to HCl.						
		24												
		25												2.5-inch spoon, 50 blows/3 inches
		26				G16253	0				200			Firm drilling, material is stiff.
		27												Cuttings: Rock chips and sandy clay clumps
		28				G16254								firm drilling
		29												
		30						Moist, Gray [N5] and multi-colored , yellow brown, greenish gray and dark gray, Bozeman Group Argillaceous Sandstone/siltstone and conglomerate, decomposed to residual soil, WELL GRADED SAND with Clay and Gravel, SW-SC, medium plasticity, weak reaction to HCl.						2-inch spoon, stuck spoon, add water, hammer in, pulled out
		31				G16255	44				93		15.5	
		32				G16256								
		33												
		34												
		35						Moist, Reddish yellow [5YR 6/6] and multi-colored, pinkish brown, olive gray and dark gray, Bozeman Group Argillaceous Sandstone/siltstone and conglomerate, decomposed to residual soil, SANDY LEAN CLAY with GRAVEL, CL, medium plasticity, weak reaction to HCl, gravels in 2 inch section, gravels react with HCl, sandy clays do not.						2.5-inch spoon, Stop blows after 1 foot to avoid getting stuck
		36				G16257	100				28		20.1	End of day, fill with casing with water until 14 feet from surface, return after 12 hours, water is at 23 feet below ground
		37				G16258					60			2-inch spoon at 36 feet, driven after 12 hours of saturation.
		38												
		39				G16259								
▼		40						Moist, Brown [7.5YR 5/3] and multi-colored, pinkish brown, yellowish tan and gray, Bozeman Group Argillaceous Sandstone/siltstone and conglomerate, decomposed to residual soil, CLAYEY GRAVEL with Sand, GC, low to medium plasticity.						Groundwater at 40.0' on 7-7-16
		41				G16260	33				200		14.8	Tried Shelby tube, too stiff, bent tube. 2.5-inch spoon, 50 blows/3 inches
		42				G16261								Consider coring, too Clayey to core
		43												Cuttings: light gray, angular chips to 1/4 inch and fines, dusty fines, low to medium plasticity
		44												

PIONEER TECHNICAL SERVICES, INC.

CLIENT: Montana Fish Wildlife and Parks

ADDRESS: 1522 9th Ave.
Helena, Montana 59620

PHONE NUMBER: 406-841-4001

DRILL HOLE LOG DRILL HOLE LOGS.GPJ 9/2/16

PROJECT NAME: Bannack State Park

Drill Hole No. BH-02

This log is part of a report prepared by Pioneer Technical, Inc. for this project and should be read with the report. This summary applies only at the location of the boring and at the time of the drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplication of actual conditions encountered.

WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	Field SPT 'N'	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		45				G16261								
		46				G16263	17	Moist to wet, Grayish brown [10YR 5/2] Bozeman Group Argillaceous Sandstone/siltstone and conglomerate, decomposed to residual soil, CLAYEY SAND, SC, medium to high plasticity.			200		18.6	2-inch spoon, 50 blows/3 inches
		47				G16262								Decide to continue ODEX, coring would wash out sample
		48												Cuttings: light brown, Sandy clay with 1/8 inch minus chips
		49												
		50				G16264	17	Wet, Brown [10YR 5/3] Bozeman Group Argillaceous Sandstone/siltstone and conglomerate, decomposed to residual soil, CLAYEY SAND, SC, low to medium plasticity, strong reaction to HCl.			50		13.0	2-inch spoon, 50 blows/3 inches
		51												
		52				G16265		Wet, Grayish brown [10YR 5/2] Bozeman Group Tuffaceous claystone, decomposed to residual soil, FAT CLAY with SAND and Gravel, CH, high plasticity, very stiff, weak reaction to HCl, with black specks, likely decomposed ash/Tuff.						Water from casing after is air turned on Cuttings: saturated light gray, fat clay, trace sand in cuttings, chips are fat clay
		53												
		54												
		55				G16266	100							Attempt shelby tube, 4 inch push, tip of tube bent by gravels
		56												
		57												Cuttings: Saturated, light gray, slurry of fat clay or claystone
		58				G16267								
		59						Wet, Yellowish brown [10YR 5/4] Bozeman Group Argillaceous Sandstone/siltstone and conglomerate, decomposed to residual soil, SANDY CLAY, CL, medium plasticity, strong reaction to HCl, trace of small pebbles.						
		60												2-inch spoon
		61				G16268					50		14.8	
		62												
		63												
		64												
		65												
		66												
		67												

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Helena, Montana 59620

PHONE NUMBER: 406-841-4001

DRILL HOLE LOG DRILL HOLE LOGS.GPJ 9/2/16

Drill Hole No. BH-03

PROJECT NAME: Bannack State Park	
DATE STARTED / FINISHED: 7/11/16 - 7/11/16	DRILLER: Axis Drilling
LOGGED BY: Jeff Riedel	DRILL TYPE: Davey-Kent
GROUND SURFACE ELEVATION: 5850.8 ft	HOLE DIAMETER: 6-inch ODEX
BOREHOLE LOCATION: (MTSP NAD 83) N354139.3510', E1067087.5670'	HAMMER TYPE: 140 lb Auto

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WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	Field SPT 'N'	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		0						Topsoil.						
		1						Dry, Dark yellowish brown [10YR 3/4], SILTY GRAVEL with Sand, GM, low plasticity, strong reaction to HCl.						Cuttings: Silty gravel, light tan, dry
		2												
		3												
		4												
		5												2-inch spoon, Cuttings: Light tan, Silty gravel, maximum 1/2 inch chips
		6				G16269	44				21		4.0	
		7				G16270								
		8												
		9												
		10						Dry, Dark yellowish brown [10YR 4/4], SILTY GRAVEL with Sand, GM, non-plastic, strong reaction to HCl.						2-inch spoon
		11				G16271					65		1.7	Driving cobble in 2nd six inches, use N=44
		12				G16272								
		13												
		14						Moist, Reddish brown [5YR 5/3] Bozeman Group Silt/Claystone and Conglomerate, decomposed to residual soil, LEAN CLAY, CL, medium plasticity, no reaction to HCl.						
		15				G16273	100							Shelby tube, 8 inch push refusal at 15.2' feet
		16				G16274		Moist, Grayish green [5G 5/2] and multi-colored, yellow brown and reddish brown, Bozeman Group Argillaceous Sandstone/siltstone and conglomerate, decomposed to residual soil, CLAYEY GRAVEL, GC, low to medium plasticity, strong reaction to HCl.			49		6.0	2-inch spoon
		17												Cuttings: Clayey gravel, 1/2 inch max chips, clay clumps
		18				G16275								
		19												
		20												
		21				G16276 G16278					150		7.3	2.5-inch spoon with brass liners, 50 blows/4 inches, broke through cobble at 40

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ADDRESS: 1522 9th Ave. Helena, Montana 59620	
PHONE NUMBER: 406-841-4001	

DRILL HOLE LOG DRILL HOLE LOGS.GPJ 9/2/16

PROJECT NAME: Bannack State Park

Drill Hole No. BH-03

WELL LOG	GRAPHIC LOG	DEPTH (FT)	SAMPLES: DRIVE	SAMPLES: UNDISTURBED	SAMPLES: BULK	SAMPLE ID	RECOVERY (%)	MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	Field SPT 'N'	DRY DENSITY (pcf)	MOISTURE (%)	REMARKS / TESTING
		22				G16277		Moist, Dark yellowish brown [10YR 4/4] and reddish brown, Bozeman Group Argillaceous Sandstone/siltstone and conglomerate, decomposed to residual soil, CLAYEY GRAVEL with Sand, GC, low to medium plasticity, weak reaction to HCl. *(Continued)*						blows, continue to drive sampler 50 blows for another 4 inches
		23				G16278								
		24												
		25						Moist, Grayish brown [10YR 5/2] and reddish brown, Bozeman Group Argillaceous Sandstone/siltstone and conglomerate, decomposed to residual soil, CLAYEY GRAVEL with Sand, GC, low to medium plasticity, strong reaction to HCl.						50 blows/5 inches
		26				G16279					120		1.8	
						G16280								
		27						Moist, Brown [7.5YR 5/3] Bozeman Group Silt/Claystone, decomposed to residual soil, SANDY CLAY with Gravel, CL, low to medium plasticity, strong reaction to HCl.						Cuttings change to gray
		28						Moist, Gray [10YR 6/1] and reddish brown, Bozeman Group Argillaceous Sandstone/siltstone and conglomerate, decomposed to residual soil, FAT CLAY with GRAVEL, CH, medium to high plasticity, strong reaction to HCl.						
		29				G16281								
		30												2.5-inch spoon with brass liners, 50 blows/4 inches
		31				G16282					150		6.2	
		32												Total Depth=31.5 feet
		33												
		34												
		35												
		36												
		37												
		38												
		39												
		40												
		41												
		42												
		43												
		44												

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PIONEER TECHNICAL SERVICES, INC.

CLIENT: Montana Fish Wildlife and Parks

ADDRESS: 1522 9th Ave.
Helena, Montana 59620

PHONE NUMBER: 406-841-4001

DRILL HOLE LOG DRILL HOLE LOGS.GPJ 9/2/16

Crumb Test Report

Project: Bannack
Lab #: G16237
Sample: TP-07 4.8-5.3'
Date: 8-4-16

Classification: Nondispersive

Remarks:
A crumb test was performed according to ASTM D 6572 to determine the dispersive properties of the sample. As suggested by ASTM this test was performed alongside a pinhole and double hydrometer test. A crumb taken from the bulk sample at natural moisture was tested as well as a remolded crumb at optimum moisture. Both crumbs had dispersion grades of 1 or "nondispersive" at the 2 minute, 1 hour, and 6 hour readings. No colloidal clouds were visible at any of the readings and the water remained completely clear.

Crumb Test

Project: Bannack
Lab #: G16237
Sample: TP-07 4.8-5.3'

Natural Crumb

Time	Grade	Grade Description	Temp
2 min	1	Nondispersive	20 C
1 h	1	Nondispersive	20 C
6h	1	Nondispersive	21 C

Remolded Crumb

Time	Grade	Grade Description	Temp
2 min	1	Nondispersive	20 C
1 h	1	Nondispersive	20 C
6h	1	Nondispersive	21 C

Grade 1 Nondispersive
Grade 2 Intermediate
Grade 3 Dispersive
Grade 4 Highly Dispersive

Pinhole Test Result Summary

Project: Bannack
Lab #: G16237
Sample ID: TP-07 4.8-5.3'

Classification: ND1 – Nondispersive clay with very slight to no colloidal erosion under 15 in. head.

Remarks:
A pinhole test was conducted in accordance with Method C of ASTM D4647. Samples were molded to 95% of maximum dry density at optimum moisture content. 2, 7, and 15 inch heads were tested. Two trials at the 2 in. head were performed and both resulted in no effluent escaping the molded sample. Further examination of these samples showed that the pinhole had swelled shut. The 7 and 15in head tests both had perfectly clear effluent containing no soil particles. The flow rates of these tests decreased throughout the trail indicating a swelling of the soil. After the trial, the pinholes were examined and determined to be smaller than the original 1mm diameter. This clay was considered to be nondispersive.

Pinhole Test
Lab # G16237

Classification = ND1

2 in. head

Volume (ml)	Cum. Vol (ml)	Time (sec)	Flow ml/sec	Classification Notes (color, particles passing etc.)
10	10	0	0	This test was ran twice. Both times the pinhole swelled shut before any water flowed out of the sample.
10	20	0	0	
10	30	0	0	
10	40	0	0	
10	50	0	0	
25	75	0	0	
25	100	0	0	
25	125	0	0	
25	150	0	0	

7 in. Head

Volume (ml)	Cum. Vol (ml)	Time (sec)	Flow ml/sec	Classification Notes (color, particles passing etc.)
10	10	6.98	1.433	Clear effluent with no particles. After dissasembly hole was smaller than 1mm. Decreasing flow rates suggest that the sample swelled.
10	20	11.13	0.898	
10	30	12.06	0.829	
10	40	13.36	0.749	
10	50	12.44	0.804	
25	75	36.39	0.687	
25	100	37.93	0.659	
25	125	39.98	0.625	
25	150	48.08	0.520	

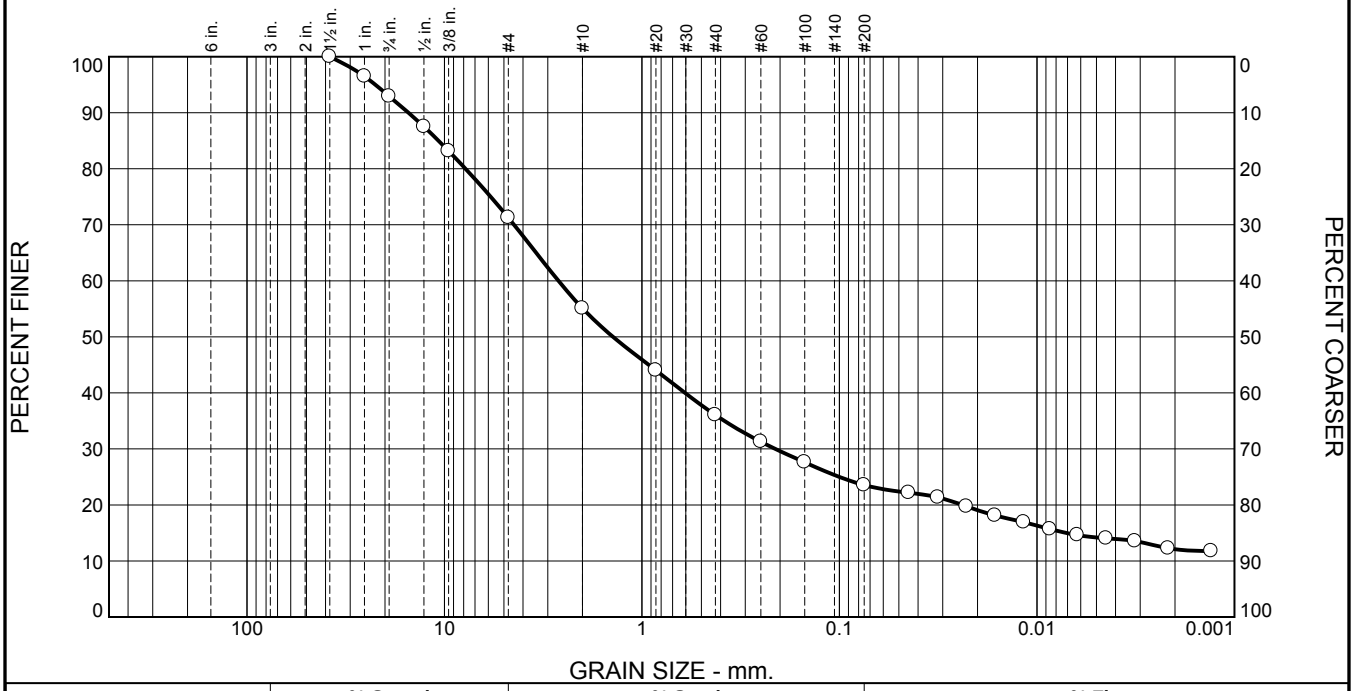
15 in. Head

Volume (ml)	Cum. Vol (ml)	Time (sec)	Flow ml/sec	Classification Notes (color, particles passing etc.)
10	10	2.86	3.497	Clear effluent with no particles. After dissasembly hole was smaller than 1mm. decreasing flowrates suggest that the sample swelled.
10	20	4.33	2.309	
10	30	4.95	2.020	
10	40	5.94	1.684	
10	50	5.75	1.739	
25	75	13.64	1.833	
25	100	15.08	1.658	
25	125	17.14	1.459	
25	150	19.9	1.256	

Double Hydrometer ASTM D4221

Sample I.D.	Laboratory Number	% Passing 0.005mm w/Sodium Metaphosphate	% Passing 0.005mm Distilled Water Only	% Dispersion
TP-07 (4.8-5.3')	G16237	63.6	1.4	2.2

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	7.1	21.6	16.2	19.0	12.5	9.4	14.2

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1 1/2	100.0		
1"	96.5		
3/4"	92.9		
1/2"	87.5		
3/8"	83.2		
#4	71.3		
#10	55.1		
#20	44.0		
#40	36.1		
#60	31.3		
#100	27.6		
#200	23.6		
0.0446 mm.	22.2		
0.0318 mm.	21.4		
0.0228 mm.	19.8		
0.0163 mm.	18.1		
0.0117 mm.	16.9		
0.0086 mm.	15.7		
0.0062 mm.	14.6		
0.0045 mm.	14.0		
0.0032 mm.	13.6		
0.0022 mm.	12.3		
0.0013 mm.	11.8		

* (no specification provided)

Material Description

Atterberg Limits (ASTM D 4318)

PL= **LL=** **PI=**

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}= 15.2366 D_{85}= 10.7229 D_{60}= 2.6478
D_{50}= 1.4010 D_{30}= 0.2108 D_{15}= 0.0071
D_{10}= C_u= C_c=

Remarks

Date Received: **Date Tested:** 8-1-16

Tested By: CA / SJ

Checked By: NG

Title: Laboratory Manager

Source of Sample: BH-02 **Depth:** 20-20.8' **Date Sampled:**

Sample Number: G16251

Pioneer Technical Services, Inc.

106 Pronghorn Trail, Suite A - Bozeman, MT 59718

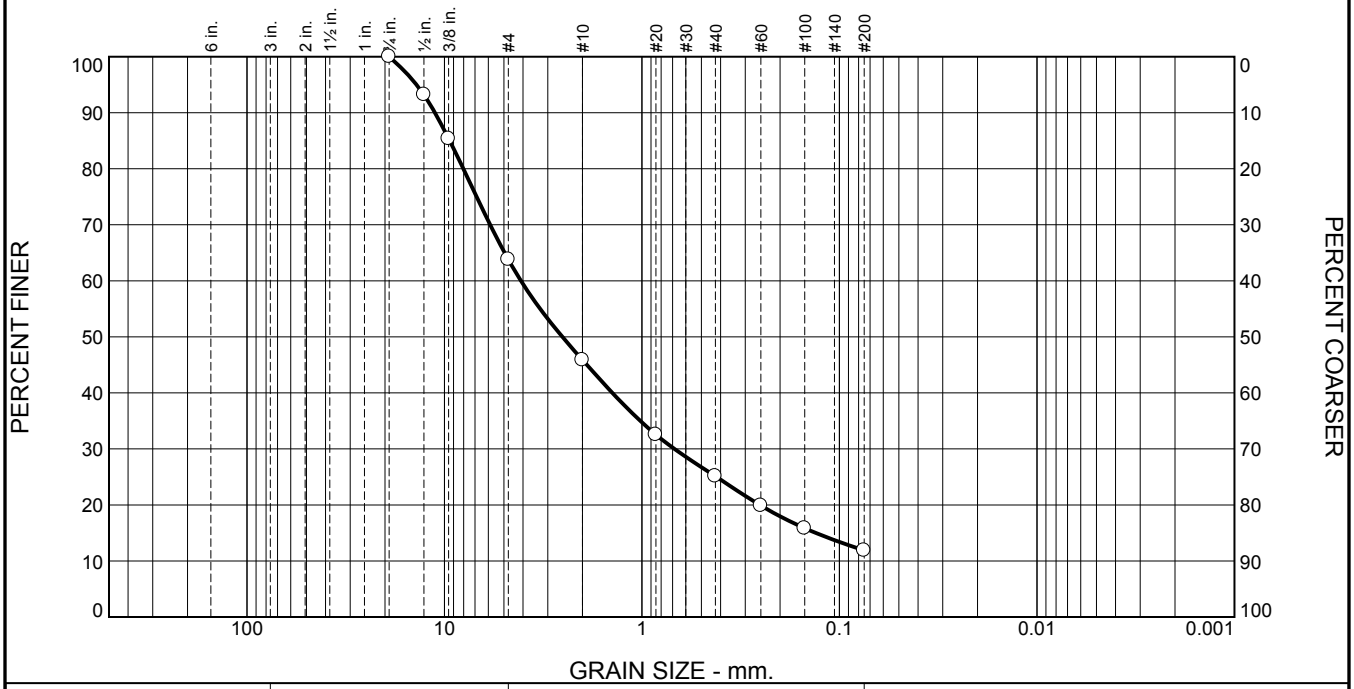
Ph. 406-388-8578 - Fax 406-388-8579

Client:

Project: Bannack

Project No: **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	36.2	17.9	20.8	13.2	11.9	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3/4"	100.0		
1/2"	93.2		
3/8"	85.4		
#4	63.8		
#10	45.9		
#20	32.5		
#40	25.1		
#60	19.9		
#100	15.8		
#200	11.9		

* (no specification provided)

Material Description

Atterberg Limits (ASTM D 4318)

PL= **LL=** **PI=**

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}= 11.1732 D_{85}= 9.4094 D_{60}= 4.0978
D_{50}= 2.5294 D_{30}= 0.6848 D_{15}= 0.1316
D_{10}= C_u= C_c=

Remarks

Date Received: 7-11-16 **Date Tested:** 7/27/16

Tested By: SJ/CA

Checked By: NG

Title: Laboratory Manager

Source of Sample: BH-02 **Depth:** 30-35' **Date Sampled:** 7-7-16

Sample Number: G16256

Pioneer Technical Services, Inc.

106 Pronghorn Trail, Suite A - Bozeman, MT 59718

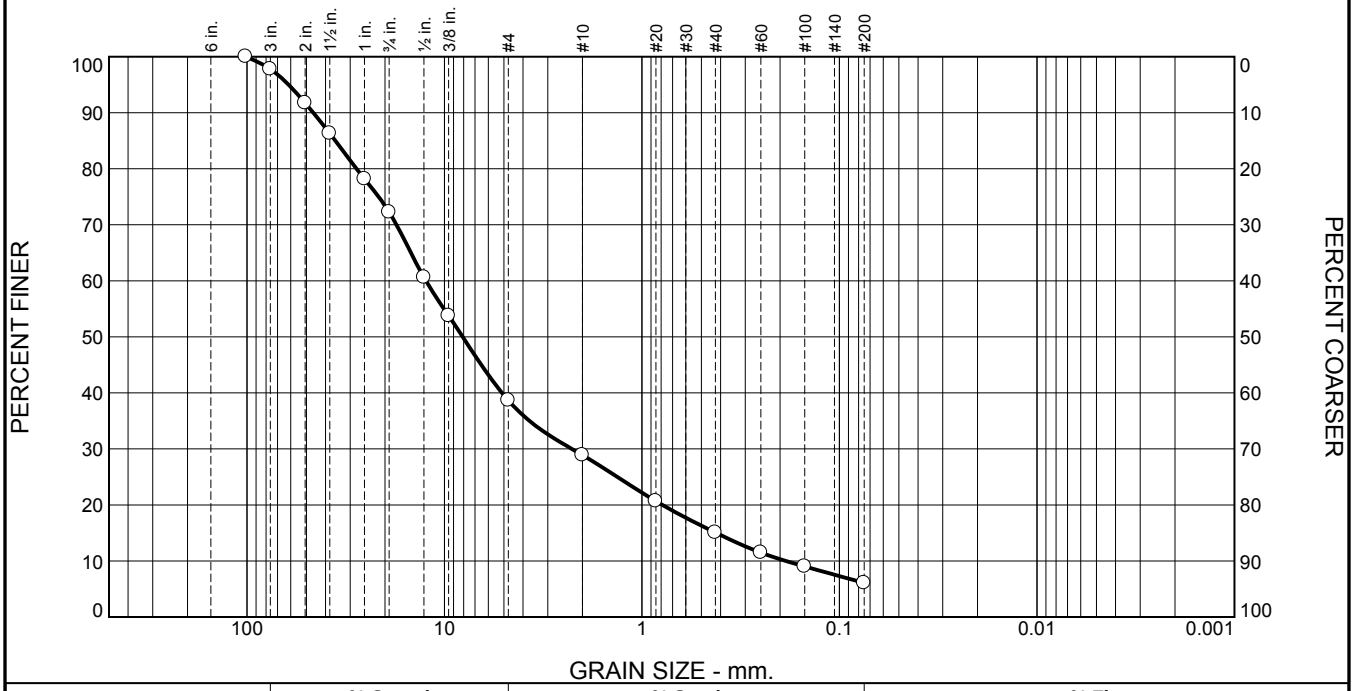
Ph. 406-388-8578 - Fax 406-388-8579

Client:

Project: Bannack

Project No: **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
2.2	25.6	33.5	9.8	13.8	9.0	6.1	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
4"	100.0		
3"	97.8		
2"	91.7		
1 1/2	86.3		
1"	78.2		
3/4"	72.2		
1/2"	60.6		
3/8"	53.8		
#4	38.7		
#10	28.9		
#20	20.7		
#40	15.1		
#60	11.5		
#100	9.0		
#200	6.1		

* (no specification provided)

Material Description

well-graded gravel with clay and sand

Atterberg Limits (ASTM D 4318)

PL= 18 **LL=** 34 **PI=** 16

Classification

USCS (D 2487)= GW-GC **AASHTO (M 145)=** A-2-6(0)

Coefficients

D_{90}= 46.1673 D_{85}= 35.6980 D_{60}= 12.4193
D_{50}= 8.0877 D_{30}= 2.2639 D_{15}= 0.4201
D_{10}= 0.1866 C_u= 66.56 C_c= 2.21

Remarks

Date Received: **Date Tested:** 7-26-16

Tested By: SJ/CA

Checked By: NG

Title: Laboratory Manager

Source of Sample: Test Pit Composite **Date Sampled:**

Sample Number: G16286

Pioneer Technical Services, Inc.

106 Pronghorn Trail, Suite A - Bozeman, MT 59718

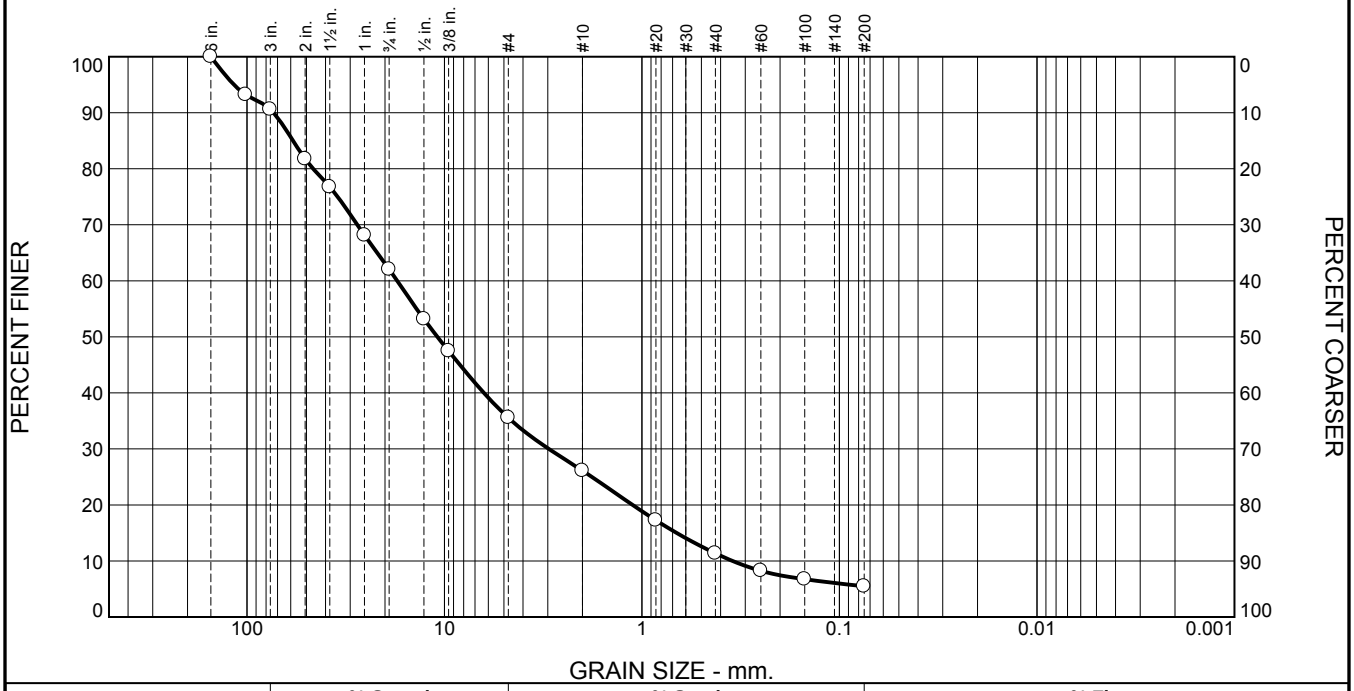
Ph. 406-388-8578 - Fax 406-388-8579

Client:

Project: Bannack

Project No: **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
9.4	28.6	26.4	9.5	14.7	5.9	5.5	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
6"	100.0		
4"	93.2		
3"	90.6		
2"	81.8		
1 1/2	76.8		
1"	68.1		
3/4"	62.0		
1/2"	53.2		
3/8"	47.5		
#4	35.6		
#10	26.1		
#20	17.3		
#40	11.4		
#60	8.2		
#100	6.8		
#200	5.5		

* (no specification provided)

Material Description

Atterberg Limits (ASTM D 4318)

PL= **LL=** **PI=**

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}= 73.3872 D_{85}= 58.5080 D_{60}= 17.3552
D_{50}= 10.8575 D_{30}= 2.9639 D_{15}= 0.6670
D_{10}= 0.3470 C_u= 50.02 C_c= 1.46

Remarks

Date Received: 7-6-16 **Date Tested:** 7/27/16

Tested By: SJ/CA

Checked By: NG

Title: Laboratory Manager

Source of Sample: TP-01 **Depth:** 6-7.0' **Date Sampled:** 7-6-16

Sample Number: G16228

Pioneer Technical Services, Inc.

106 Pronghorn Trail, Suite A - Bozeman, MT 59718

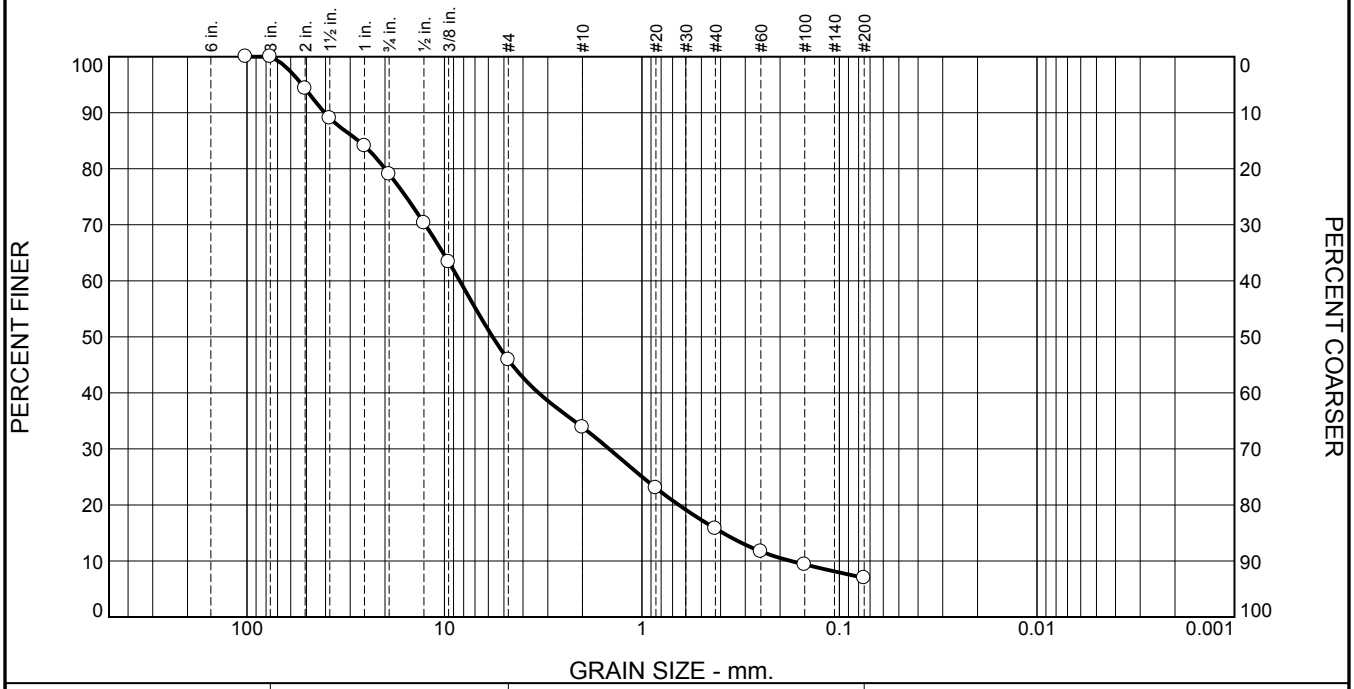
Ph. 406-388-8578 - Fax 406-388-8579

Client:

Project: Bannack

Project No: **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	21.0	33.1	12.0	18.1	8.8	7.0	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
4"	100.0		
3"	100.0		
2"	94.3		
1 1/2	89.0		
1"	84.1		
3/4"	79.0		
1/2"	70.3		
3/8"	63.4		
#4	45.9		
#10	33.9		
#20	23.0		
#40	15.8		
#60	11.7		
#100	9.4		
#200	7.0		

* (no specification provided)

Material Description

Atterberg Limits (ASTM D 4318)

PL= **LL=** **PI=**

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}= 40.4238 D_{85}= 27.2677 D_{60}= 8.3737
D_{50}= 5.7025 D_{30}= 1.4664 D_{15}= 0.3885
D_{10}= 0.1764 C_u= 47.46 C_c= 1.46

Remarks

Date Received: 7-6-16 **Date Tested:** 7/27/16

Tested By: SJ/CA

Checked By: NG

Title: Laboratory Manager

Source of Sample: TP-02 **Depth:** 9-10.0' **Date Sampled:** 7-6-16

Sample Number: G16229

Pioneer Technical Services, Inc.

106 Pronghorn Trail, Suite A - Bozeman, MT 59718

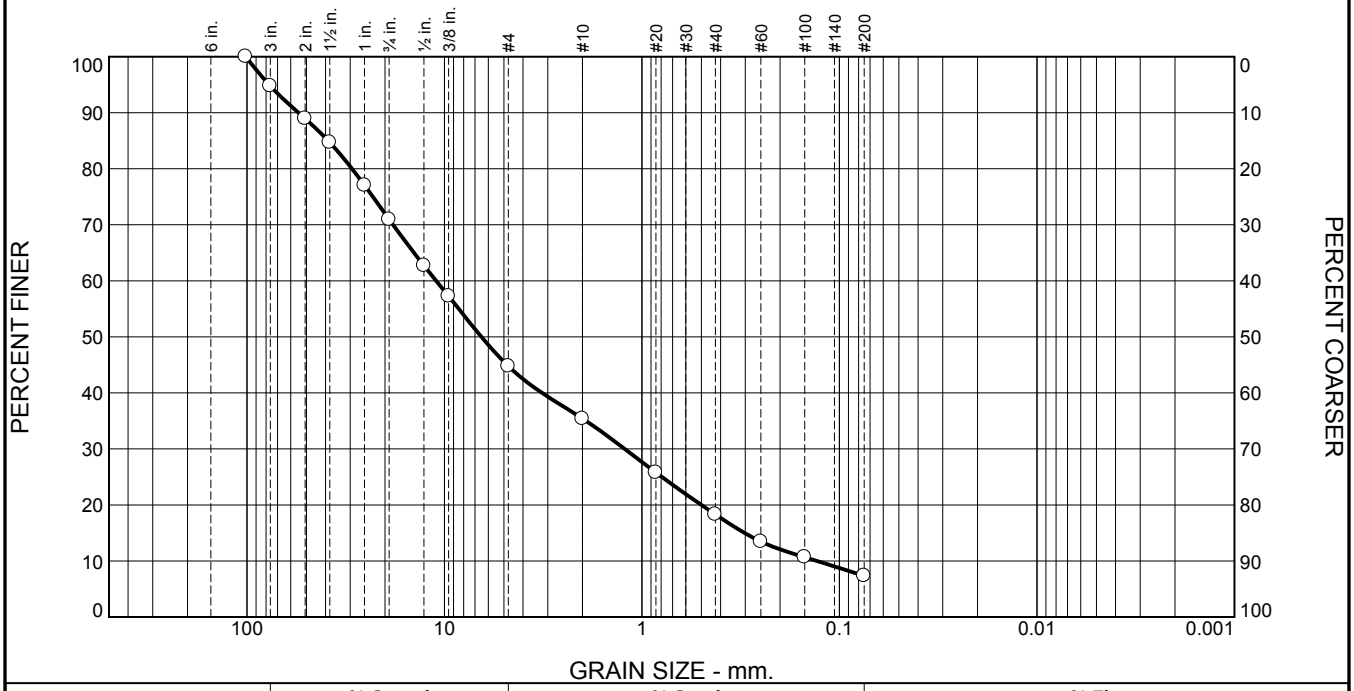
Ph. 406-388-8578 - Fax 406-388-8579

Client:

Project: Bannack

Project No: **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
5.2	23.9	26.1	9.4	17.1	11.0	7.3	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
4"	100.0		
3"	94.8		
2"	89.0		
1 1/2	84.7		
1"	77.0		
3/4"	70.9		
1/2"	62.7		
3/8"	57.3		
#4	44.8		
#10	35.4		
#20	25.8		
#40	18.3		
#60	13.5		
#100	10.7		
#200	7.3		

* (no specification provided)

Material Description

Atterberg Limits (ASTM D 4318)

PL= **LL=** **PI=**

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}= 54.8806 D_{85}= 38.8100 D_{60}= 11.0138
D_{50}= 6.4976 D_{30}= 1.2224 D_{15}= 0.3021
D_{10}= 0.1300 C_u= 84.74 C_c= 1.04

Remarks

Date Received: 7-6-16 **Date Tested:** 7/27/16

Tested By: SJ/CA

Checked By: NG

Title: Laboratory Manager

Source of Sample: TP-04 **Depth:** 7.5-9' **Date Sampled:** 7-6-16

Sample Number: G16232

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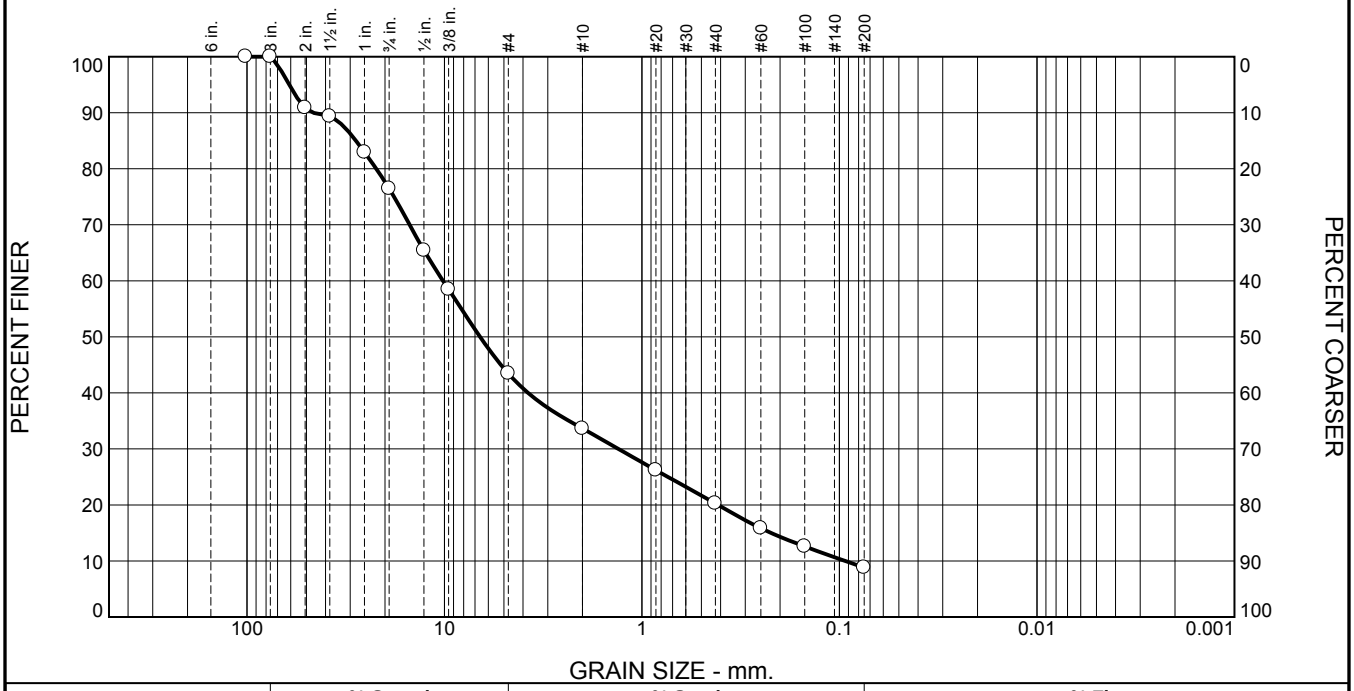
Client:

Project: Bannack

Project No: **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	23.6	32.9	9.9	13.3	11.5	8.8	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
4"	100.0		
3"	100.0		
2"	90.9		
1 1/2	89.4		
1"	82.9		
3/4"	76.4		
1/2"	65.4		
3/8"	58.5		
#4	43.5		
#10	33.6		
#20	26.2		
#40	20.3		
#60	15.9		
#100	12.6		
#200	8.8		

* (no specification provided)

Material Description

Atterberg Limits (ASTM D 4318)

PL= **LL=** **PI=**

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}= 46.1763 D_{85}= 28.0910 D_{60}= 10.1673
D_{50}= 6.5988 D_{30}= 1.3151 D_{15}= 0.2217
D_{10}= 0.0935 C_u= 108.76 C_c= 1.82

Remarks

Date Received: 7-6-16 **Date Tested:** 7/27/16

Tested By: SJ/CA

Checked By: NG

Title: Laboratory Manager

Source of Sample: TP-05 **Depth:** 10-12.2' **Date Sampled:** 7-6-16

Sample Number: G16235

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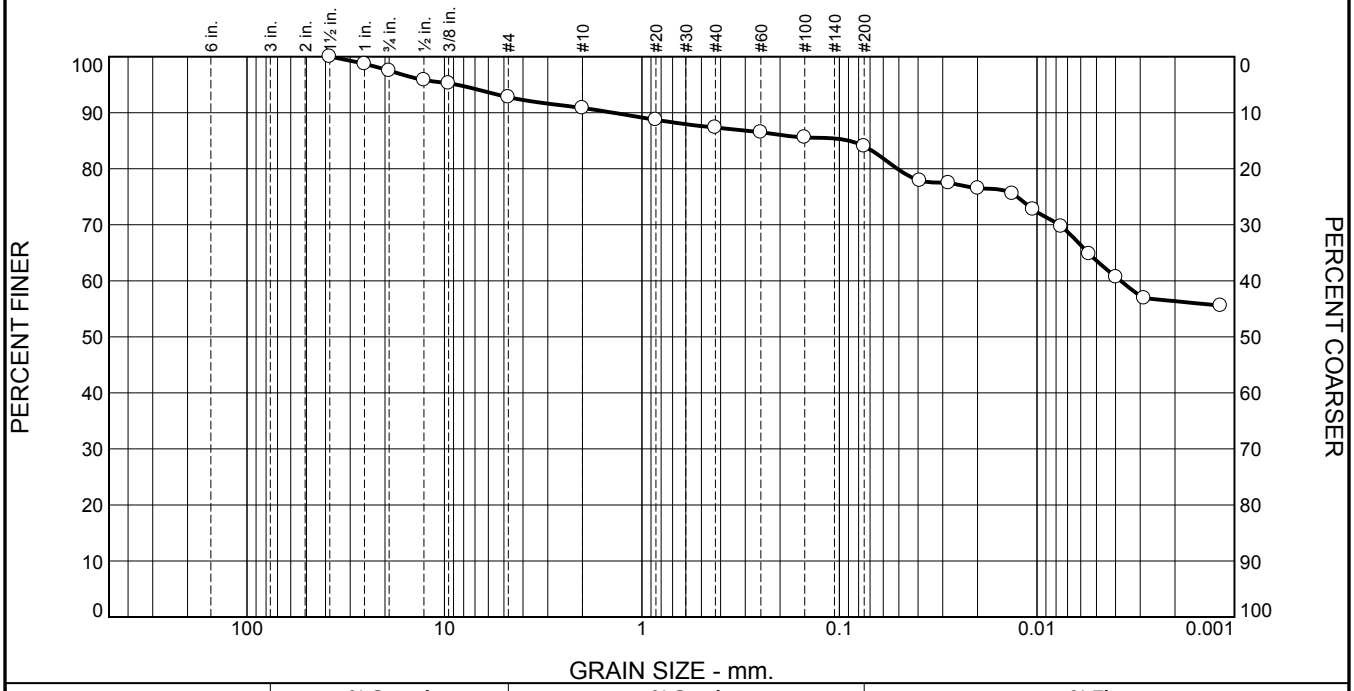
Client:

Project: Bannack

Project No: **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	2.5	4.7	2.0	3.5	3.3	20.4	63.6

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1 1/2	100.0		
1"	98.7		
3/4"	97.5		
1/2"	95.8		
3/8"	95.2		
#4	92.8		
#10	90.8		
#20	88.7		
#40	87.3		
#60	86.5		
#100	85.6		
#200	84.0		
0.0392 mm.	77.9		
0.0280 mm.	77.4		
0.0199 mm.	76.5		
0.0133 mm.	75.6		
0.0105 mm.	72.7		
0.0075 mm.	69.7		
0.0054 mm.	64.8		
0.0040 mm.	60.7		
0.0029 mm.	56.9		
0.0012 mm.	55.6		

* (no specification provided)

Material Description

fat clay with sand

Atterberg Limits (ASTM D 4318)

PL= 37 **LL=** 93 **PI=** 56

Classification

USCS (D 2487)= CH **AASHTO (M 145)=** A-7-5(55)

Coefficients

D_{90}= 1.3994 D_{85}= 0.0893 D_{60}= 0.0038
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Double hydrometer with sodium metaphosphate

Date Received: **Date Tested:** 7-29-16

Tested By: CA, SJ

Checked By: NG

Title: Laboratory Manager

Source of Sample: TP-07 **Depth:** 4.8-5.3' **Date Sampled:**

Sample Number: G16237-A

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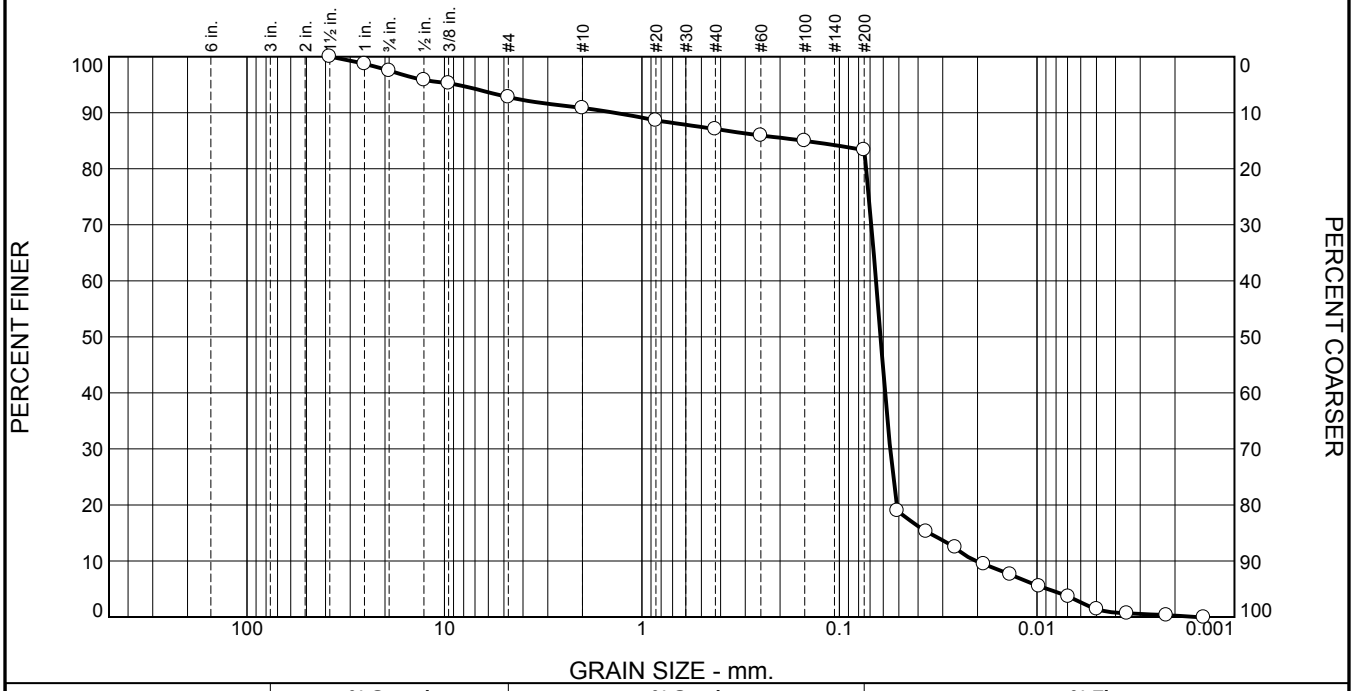
Client:

Project: Bannack

Project No: **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	2.5	4.7	2.0	3.7	3.8	81.9	1.4

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1 1/2	100.0		
1"	98.7		
3/4"	97.5		
1/2"	95.8		
3/8"	95.2		
#4	92.8		
#10	90.8		
#20	88.6		
#40	87.1		
#60	85.9		
#100	85.0		
#200	83.3		
0.0508 mm.	19.0		
0.0363 mm.	15.2		
0.0259 mm.	12.4		
0.0186 mm.	9.4		
0.0136 mm.	7.6		
0.0098 mm.	5.5		
0.0069 mm.	3.7		
0.0050 mm.	1.4		
0.0035 mm.	0.7		
0.0022 mm.	0.3		
0.0014 mm.			

* (no specification provided)

Material Description

fat clay with sand

Atterberg Limits (ASTM D 4318)

PL= 37 **LL=** 93 **PI=** 56

Classification

USCS (D 2487)= CH **AASHTO (M 145)=** A-7-5(54)

Coefficients

D_{90}= 1.3771 D_{85}= 0.1515 D_{60}= 0.0653
D_{50}= 0.0620 D_{30}= 0.0554 D_{15}= 0.0353
D_{10}= 0.0203 C_u= 3.22 C_c= 2.31

Remarks

Double hydrometer, with de-ionized water

Date Received: **Date Tested:** 8-2-16

Tested By: SJ/CA

Checked By: NG

Title: Laboratory Manager

Source of Sample: TP-07 **Depth:** 4.8-5.3' **Date Sampled:**

Sample Number: G16237-B

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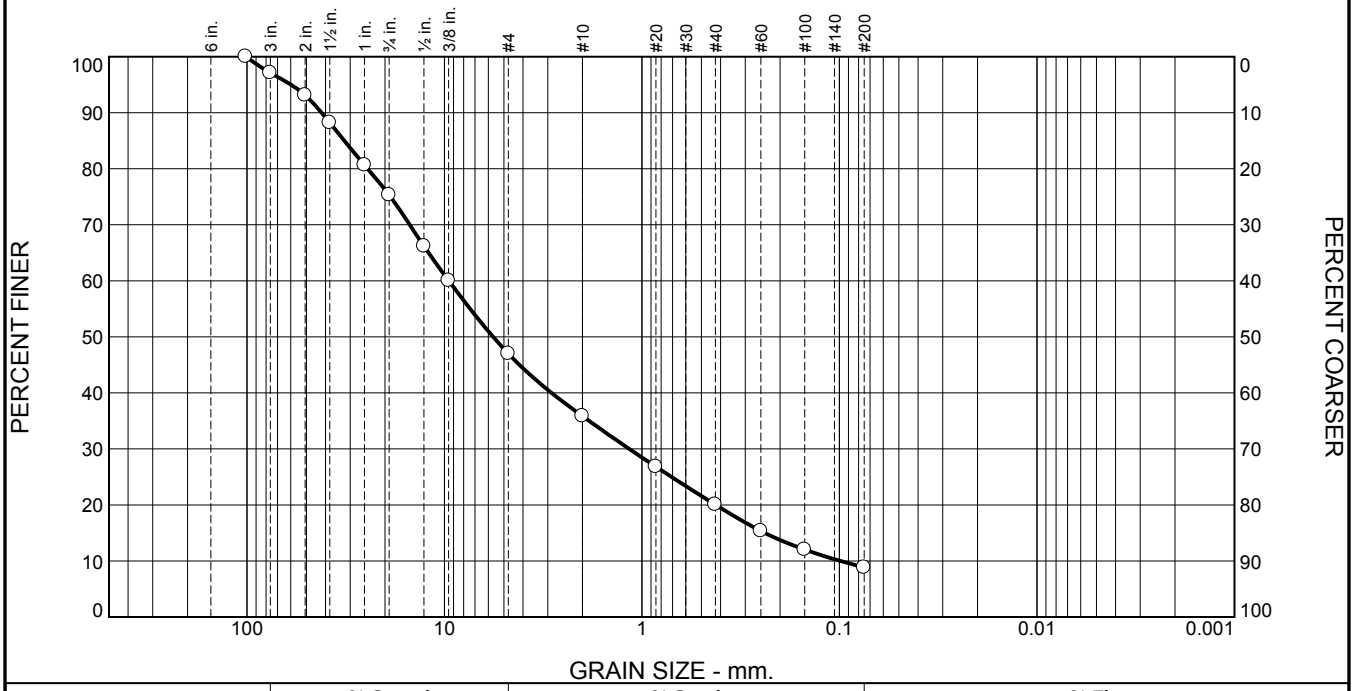
Client:

Project: Bannack

Project No: **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
2.9	21.8	28.3	11.2	15.7	11.3	8.8	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
4"	100.0		
3"	97.1		
2"	93.1		
1 1/2	88.2		
1"	80.6		
3/4"	75.3		
1/2"	66.2		
3/8"	60.1		
#4	47.0		
#10	35.8		
#20	26.8		
#40	20.1		
#60	15.4		
#100	12.0		
#200	8.8		

* (no specification provided)

Material Description

Composite TP-07 3-4.5' and TP-07 8-9.0'

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS (D 2487)= AASHTO (M 145)=

Coefficients

D_{90}= 41.9149 D_{85}= 32.1445 D_{60}= 9.5015
D_{50}= 5.6686 D_{30}= 1.1588 D_{15}= 0.2385
D_{10}= 0.0985 C_u= 96.46 C_c= 1.43

Remarks

Date Received: **Date Tested:** 7-28-16

Tested By: SJ/CA

Checked By: NG

Title: Laboratory Manager

Source of Sample: TP-07 **Date Sampled:**

Sample Number: G16287

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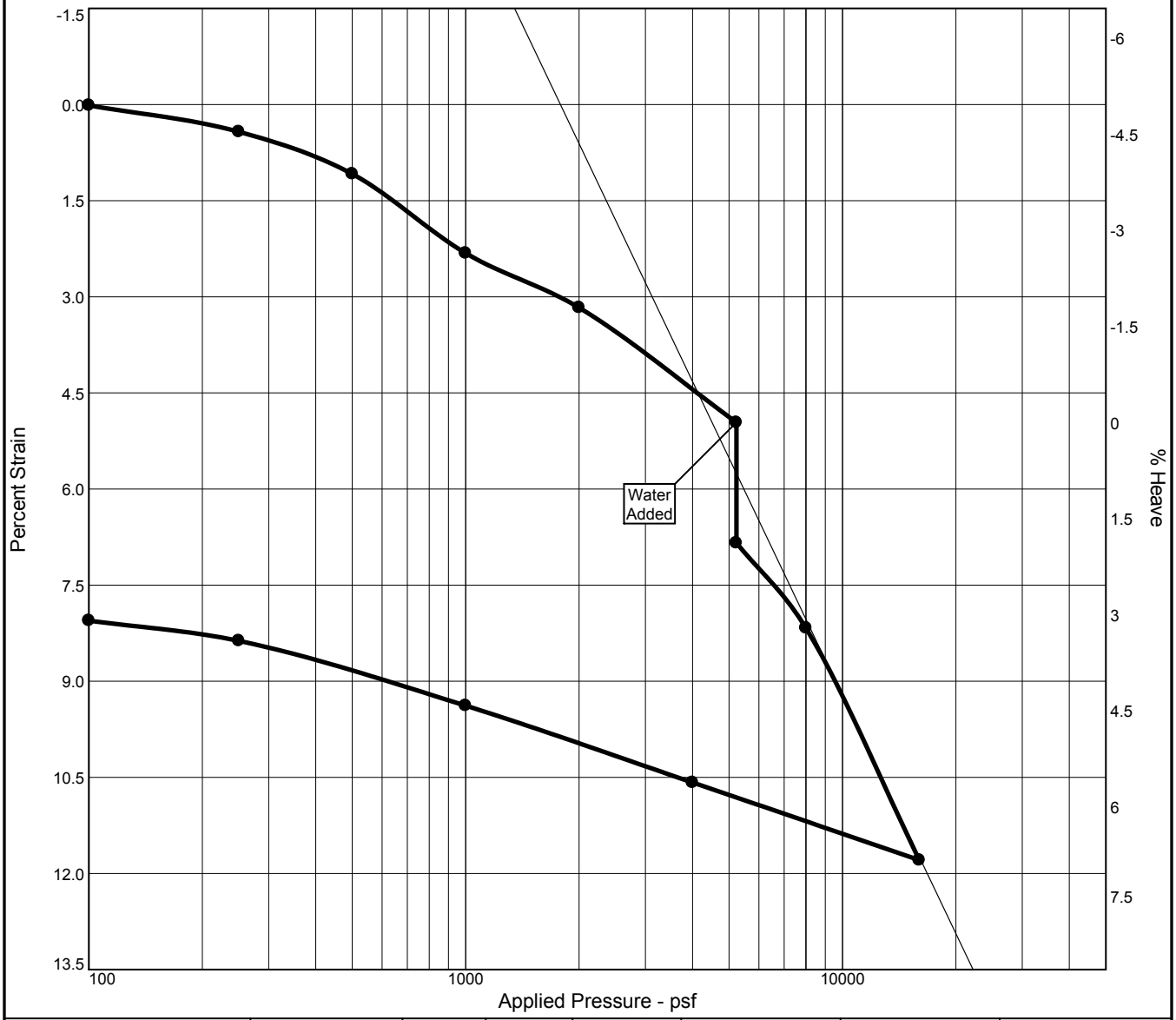
Client:

Project: Bannack

Project No: **Figure**

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	USCS	AASHTO	Initial Void Ratio
Saturation	Moisture							
28.6 %	5.7 %	108.2			2.65			0.529

MATERIAL DESCRIPTION

Project No. **Client:**

Project: Bannack

Source of Sample: BH-03 **Depth:** 14.5-15.2' **Sample Number:** G16273

Remarks:
Specific Gravity assumed

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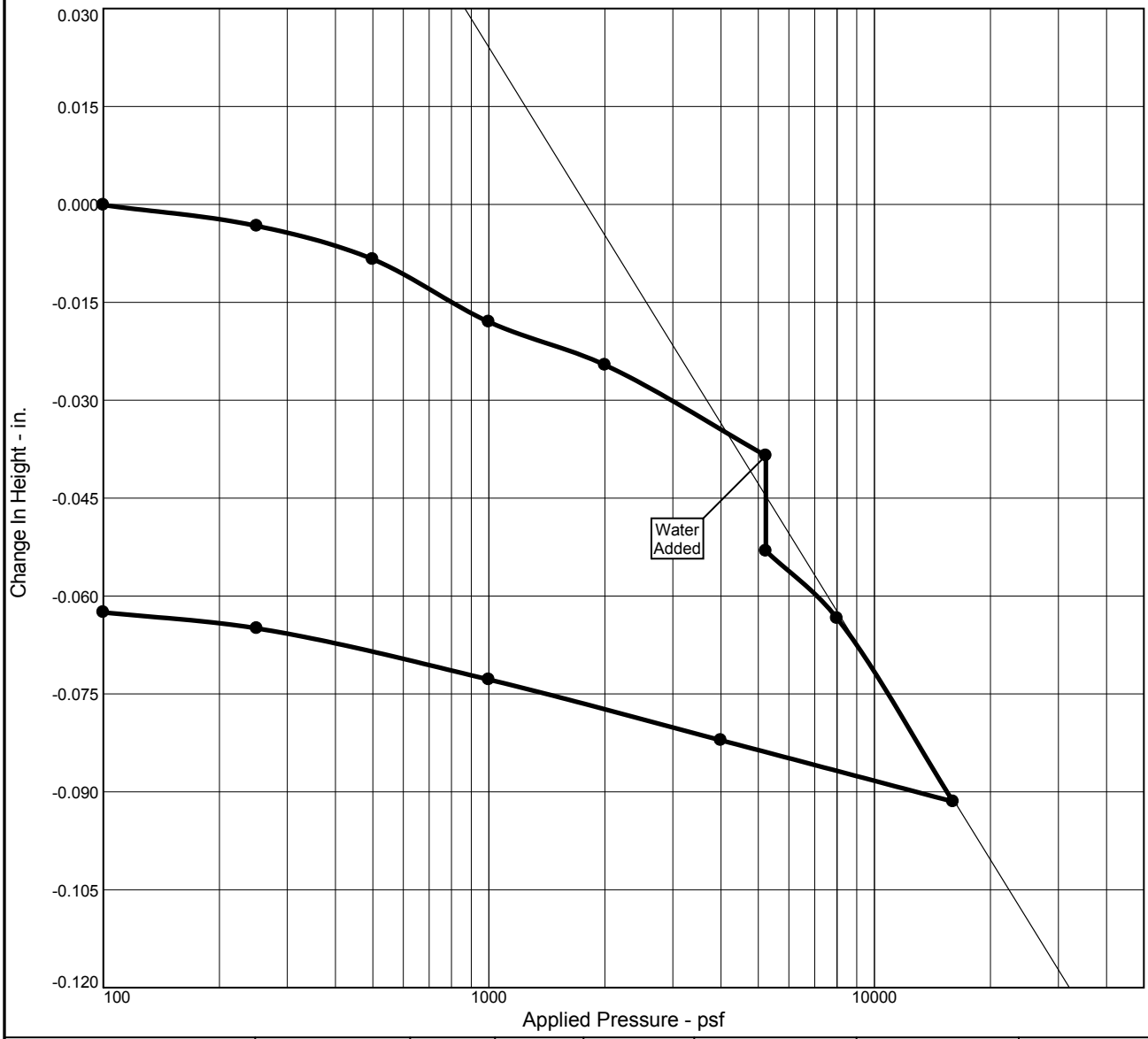
Figure

Tested By: NG

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	USCS	AASHTO	Initial Void Ratio
Saturation	Moisture							
28.6 %	5.7 %	108.2			2.65			0.529

MATERIAL DESCRIPTION

Project No. **Client:**

Project: Bannack

Source of Sample: BH-03 **Depth:** 14.5-15.2' **Sample Number:** G16273

Remarks:
Specific Gravity assumed

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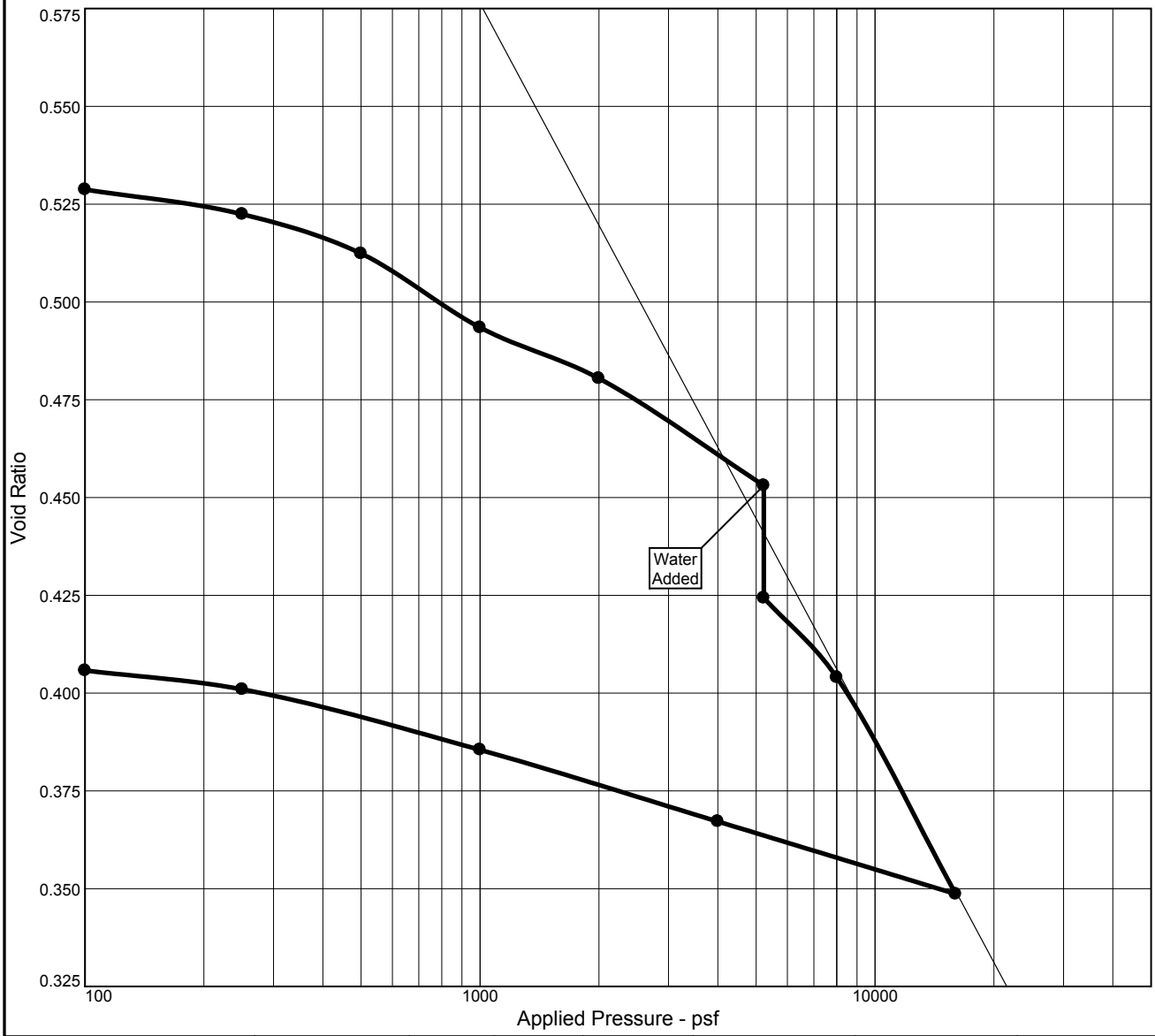
Figure

Tested By: NG

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	USCS	AASHTO	Initial Void Ratio
Saturation	Moisture							
28.6 %	5.7 %	108.2			2.65			0.529

MATERIAL DESCRIPTION

Project No. **Client:**

Project: Bannack

Source of Sample: BH-03 **Depth:** 14.5-15.2' **Sample Number:** G16273

Remarks:
Specific Gravity assumed

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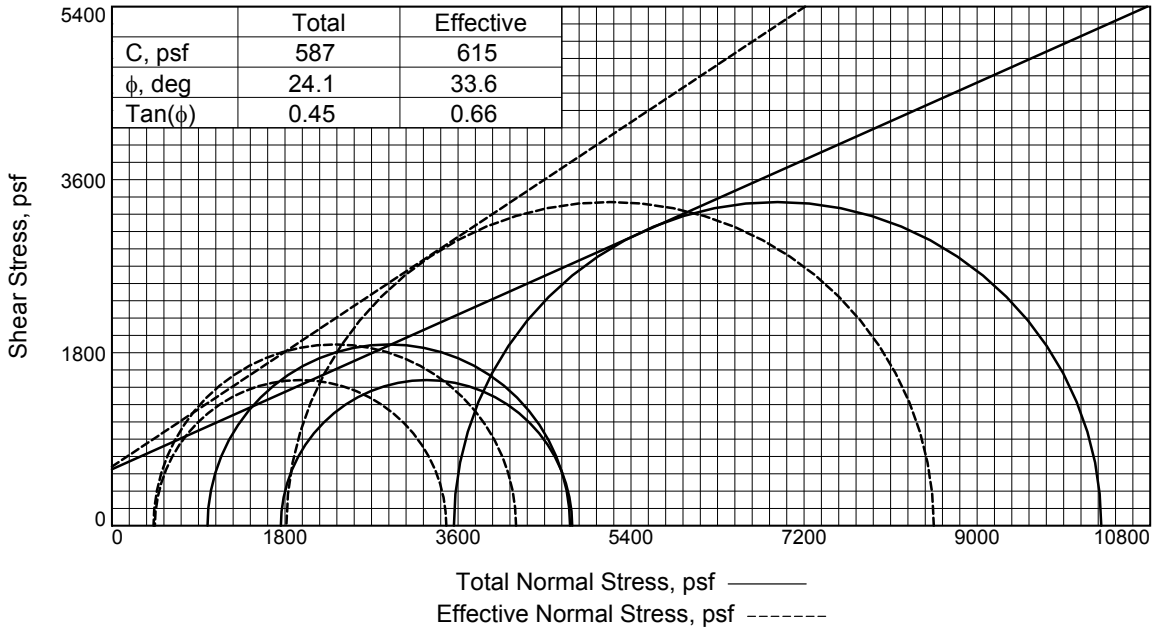
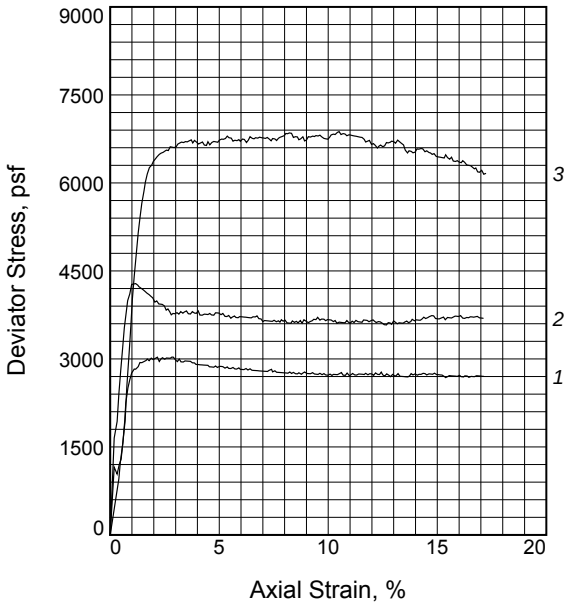
Figure

Tested By: NG





Sample No.		1	2	3
Initial	Water Content, %	10.7	10.6	10.6
	Dry Density, pcf	112.8	112.8	112.8
	Saturation, %	61.0	60.3	60.3
	Void Ratio	0.4665	0.4668	0.4672
	Diameter, in.	2.80	2.80	2.80
	Height, in.	6.00	6.00	6.00
At Test	Water Content, %	16.0	14.6	14.1
	Dry Density, pcf	112.8	112.8	112.8
	Saturation, %	90.9	83.0	80.0
	Void Ratio	0.4665	0.4668	0.4672
	Diameter, in.	2.80	2.80	2.80
	Height, in.	6.00	6.00	6.00
Strain rate, in./min.		0.05	0.05	0.05
Eff. Cell Pressure, psi		12.20	6.90	24.70
Fail. Stress, psf		3031	3771	6735
Total Pore Pr., psf		13550	11506	11218
Strain, %		2.8	3.0	3.7
Ult. Stress, psf		2874	3694	6733
Total Pore Pr., psf		13565	11678	11232
Strain, %		5.0	5.5	5.0
$\bar{\sigma}_1$ Failure, psf		3478	4203	8549
$\bar{\sigma}_3$ Failure, psf		446	432	1814

Type of Test:
CU with Pore Pressures

Sample Type:

Description: well-graded gravel with clay and sand

LL= 34 **PL=** 18 **PI=** 16

Assumed Specific Gravity= 2.65

Remarks:

Figure _____

Client:

Project: Bannack

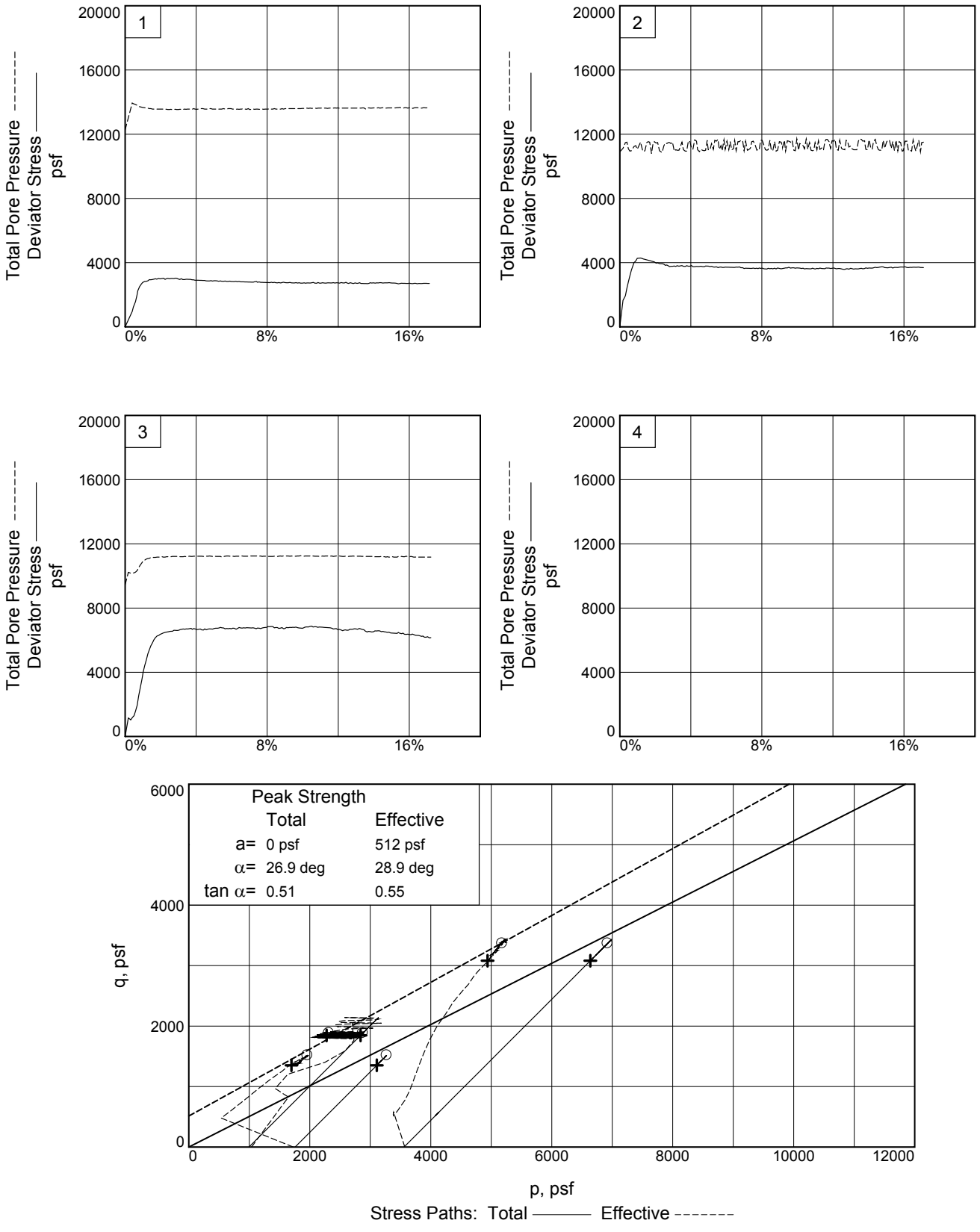
Source of Sample: Test Pit Composite

Sample Number: G16286

Proj. No.: **Date Sampled:**

TRIAXIAL SHEAR TEST REPORT
Pioneer Technical Services, Inc.
106 Pronghorn Trail, Suite A - Bozeman, MT 59718

Tested By: NG



Client:

Project: Bannack

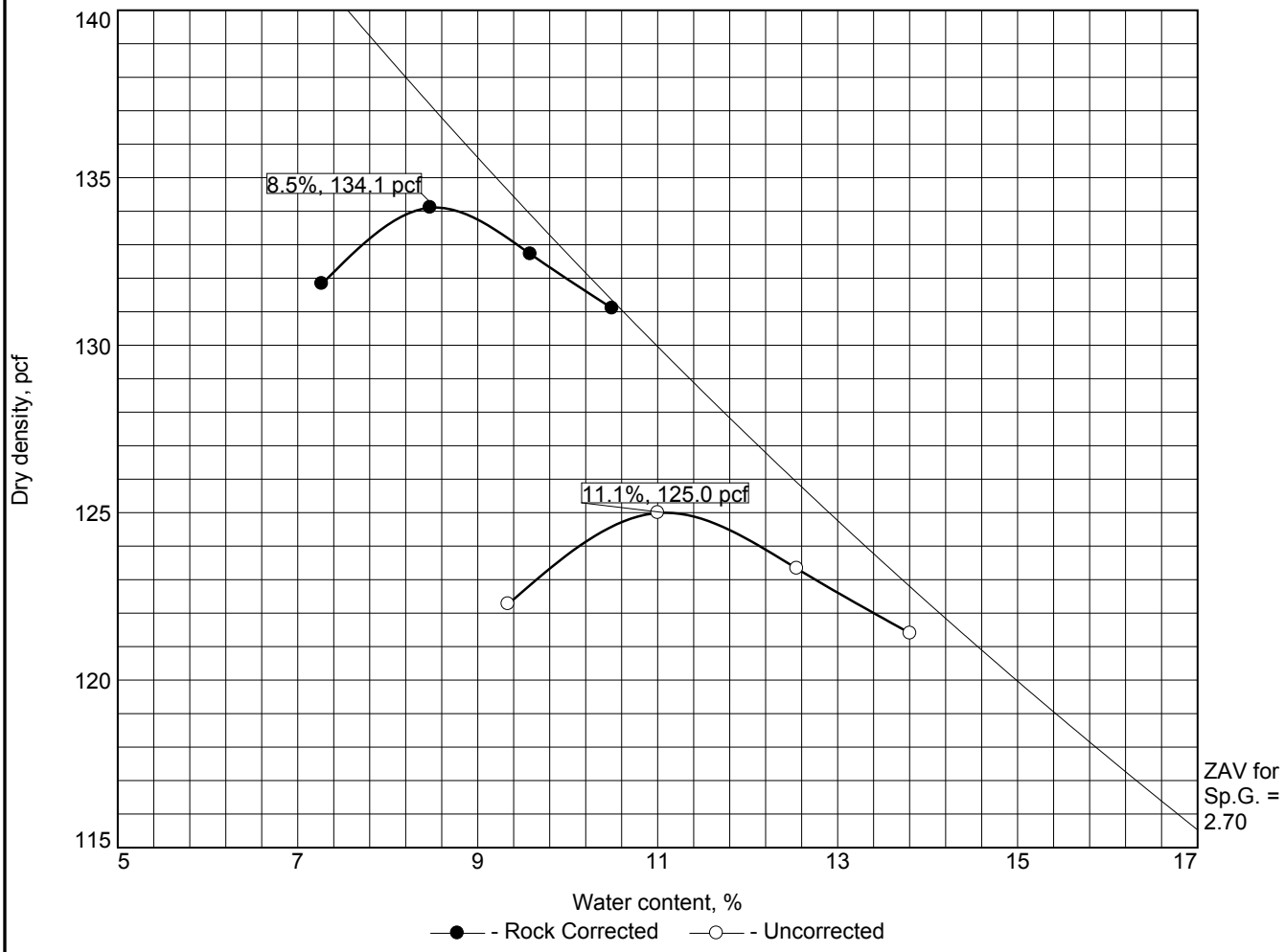
Source of Sample: Test Pit Composite **Sample Number:** G16286

Project No.: **Figure** _____

Pioneer Technical Services, Inc.

Tested By: NG

COMPACTION TEST REPORT



Test specification: ASTM D 698-12 Method C Standard
ASTM D 4718-87 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/4 in.	% < No.200
	USCS	AASHTO						
	GW-GC	A-2-6(0)			34	16	27.8	6.1

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 134.1 pcf	125.0 pcf	well-graded gravel with clay and sand
Optimum moisture = 8.5 %	11.1 %	

Project No. **Client:**
Project: Bannack

○**Source of Sample:** Test Pit Composite **Sample Number:** G16286

Remarks:
Oversize specific gravity assumed at 2.65

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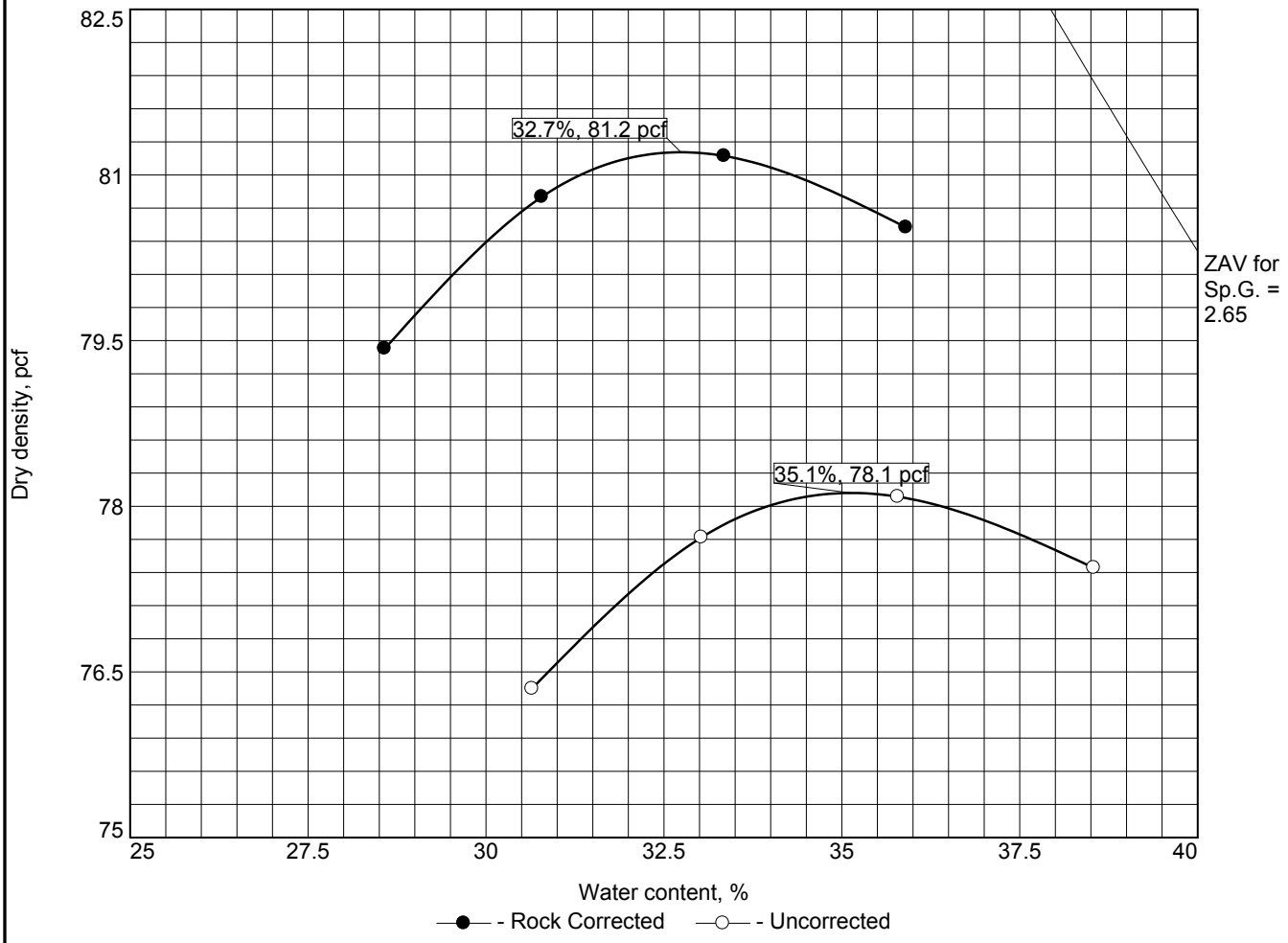
Figure

Tested By: SJ **Checked By:** NG

COMPACTION TEST REPORT



Test specification: ASTM D 698-12 Method A Standard
ASTM D 4718-87 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > #4	% < No.200
	USCS	AASHTO						
4.8-5.3'	CH	A-7-5(55)			93	56	7.2	84.0

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 81.2 pcf	78.1 pcf	fat clay with sand
Optimum moisture = 32.7 %	35.1 %	

Project No. **Client:**
Project: Bannack

○**Source of Sample:** TP-07 **Sample Number:** G16237-A

Remarks:
Oversize specific gravity assumed at 2.65

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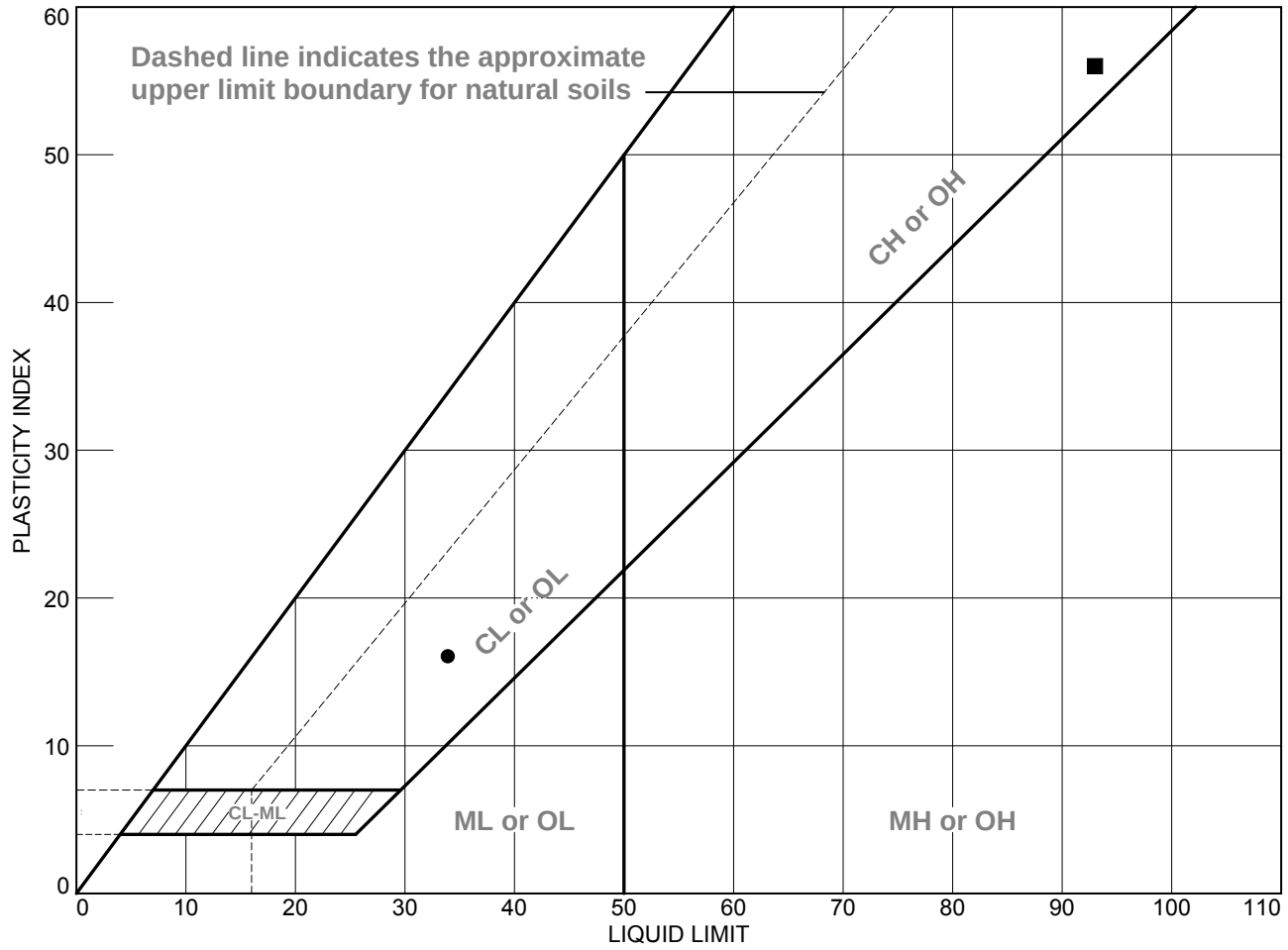
Figure

Tested By: CA/SJ **Checked By:** NG

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	Test Pit Composite	G16286			18	34	16	GW-GC
■	TP-07	G16237-A	4.8-5.3'		37	93	56	CH

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Client:
Project: Bannack
Project No.: **Figure**

Tested By: ○ RG ☐ SJ **Checked By:** NG

HYDRAULIC CONDUCTIVITY FOR FLEXIBLE-WALLED TEST SAMPLES
FALLING HEAD APPARATUS, ASTM D5084

Client:	Montana State Parks						**Project:**	Bannack			
Sample Description:	G16286-A										
Test Specimen											
Dry Density (pcf):		112.8									
% Max. ASTM D-698:		95%									
Specimen Length (cm):		15.24									
Specimen Diameter (cm):		7.112									
				Testing Equipment							
				Height Inlet Above Floor (cm):							
				Height Outlet Above Bench (cm):		21.9					
				Area of Standpipe (cm^2):		0.912					

Increment Number	Initial Reading Influent (cm^3)	Inital Reading Effluent (cm^3)	Final Reading Influent (cm^3)	Final Reading Effluent (cm^3)	Time Increment (min.)	Applied Pressure Differential (psi)	Initial Head (cm)	Final Head (cm)	Average Hydraulic Gradient (cm/cm)	Hydraulic Conductivity (cm/sec)	Hydraulic Conductivity at 20 C (cm/sec)
1	3.6	36.1	23	16.9	25	1.6	142.12	106.92	8.17	3.3E-05	3.2E-05
2	23	16.9	34.1	5.7	27	1.6	106.92	86.58	6.35	2.3E-05	2.2E-05
3	2	43.6	19.05	26.4	22	1.7	157.45	126.21	9.31	2.9E-05	2.8E-05
4	19.05	26.4	31.2	14.2	26	1.7	126.21	104.01	7.55	2.2E-05	2.1E-05
5	1.5	43.7	17.6	27.6	25	1.7	158.00	128.63	9.40	2.4E-05	2.3E-05
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16	Average Hydraulic Conductivity of Last Four Test Increments =							**2.3E-05**	**cm/sec**		
17											
18											
19											
20											
21											

k = (aL/At) ln (h1/h2)

Water Content Before Test		Water Content After Test	
Tare #		Tare #	
Wet Soil + Tare (grams)	1211.50	Wet Soil + Tare (grams)	1672.00
Dry Soil + Tare (grams)	1094.00	Dry Soil + Tare (grams)	1497.00
Tare Weight (grams)	0.00	Tare Weight (grams)	403.00
Water Content (%)	10.74	Water Content (%)	16.00
Source	Specimen	Source	Specimen